CURRENT SCIENCE

Vol. VII] September 1938 [No. 3

Government and Medical Service.

IN a recent public address* Rao Bahadur Dr. A. Lakshmanaswami Mudaliar observed that:

> "Occasionally a discordant note is struck and not infrequently the criticism is levelled against scientific workers that their work is not immediately of benefit to the crying needs of the country, and has no practical value to Statesmen and Politicians, or that their work has only led to the discoveries being utilised for increasing the destructive forces against humanity. That either of these criticisms is not justified will be apparent to any student of science."

Almost simultaneously Lord Rayleigh in the second part of his presidential address to the British Association for the Advancement of Science remarked:

> "Science, it is urged, is the source of all the trouble: and we may look to scientific men for some constructive contribution to finding a remedy. It is worthwhile to enquire what basis there is for this indictment, and whether in fact, it is feasible for men of science to desist from labours which may have a disastrous outcome, or at any rate to help in finding other men to use and not to abuse the fruits of those labours."

Science is primarily the study of Nature in all her moods and tenses and her gifts are absolutely unmoral. They acquire an adjectival character only when man hastens to stand noun substantive to them. The business of science is neither to kill nor to save human life. Its only function is to add to the general stock of knowledge. When we apply this knowledge to human affairs, questions of value arise. In view of the abuse made of certain branches of scientific knowledge, leading to the destruction of civil populations, scientists may perhaps consider the desirability of reverting to the ancient practice of hiding their light under communal bushels; and it may not be unwise to do so, because human society in the middle of the twentieth century is still like a giddy-minded girl whose wisdom has not kept pace with the accumulation of fortunes. It looks as though a new type of society has to merge into being for handling the gifts of science without reproach and with beneficence for all.

* The Sri Krishnarajendra Silver Jubilee Lecture, 1938, University of Mysore.

The Jubilee address was set in a historical background, and the main thesis was " that while curative medicine has got a large part to play in alleviating the suffering and relieving the distress of individuals, it is in the wider field of preventive medicine that the real solution lies for the eradication of disease ". Illness has an economic aspect which ought to receive comparatively wider attention in the programme of measures devised by society and governments for ensuring the health and happiness of the civil populations. It must be borne in mind that the economic loss comprehends not only the monetary cost of combating ill-health, but also the diminishing return due to sickness. If these two sides are added together in order properly to show the purely financial or numerical assessment of the cost of ill-health to the nation, governments may be induced to make a far greater contribution towards the prevention and speedy relief of sickness or disablement in the social community, whose health represents its prosperity. While reflecting the rapid changes taking place around us, we sometimes wonder how far and in what manner a government's capacity for service to its citizens in this direction is conditioned by its form. We are not indifferent to the converse study,— in the manner and the degree in which the citizen must serve his government in order that the fullest possibilities of government may be achieved. The capacity of the citizen at once to serve the government and to be guided by it, and thus to make of government a living partnership is, we think, dependent upon a wider, more explicit and more continuous education of the public than now obtains in the fundamental concerns upon which both government and the life of the individual citizen are predicated. Without such co-operation we must continue to have a people whose health, education and employability would be eternally irritating problems.

Dr. Lakshmanaswami Mudaliar has given an enhanced conception of what national health really is, which is one of a very positive nature. It relates not only to the absence of diseases, and the proper functions fulfilled by the members of the community, but it embraces the sum total of human personality. It concerns not only with the bodily structure, but with every fibre of the mind and even with character. The responsibility in promoting these wider aims, fuller conceptions and increased values is mainly to be shared by the medical profession, governments and the individuals. The Jubilee Lecture emphasises the immediate medical responsibility arising from the results of recent research in medicine, surgery and the allied sciences, the possibilities of which have been realised in immunisation against epidemics or infective diseases, the functioning and control of the neuro-endocrine system, the new psychological approach to the study of the human mind, and the treatment of civilisation disorders, the analysis of food-stuffs and the fundamental importance of vitamins and the new science of genetics, disclosing the nature and mechanism of human heredity. Do the politicians who control the destiny of large populations, have the necessary acquaintance with the contributions which the human sciences are making to the social problems, which they have to study and solve. It seems to us that viewed from the wider standpoint the responsibility of maintaining and improving the health of a population has passed from the medical profession to government action. Yet the paramount responsibility of the individual for his own health and for his own local environment remains. The efforts of the medical profession and of governments are easily nullified by individual ignorance and unwisdom. We consider that more than " Wardhaising " our schools, a definite curriculum for the inculcation of health habits in the elementary schools, the instruction in biology, hygiene and health knowledge in the higher stages, and the encouragement and training in health wisdom in the later years of education would seem to be urgently called for, and such a policy might undoubtedly prove more significant to the interests of the community, than the futile efforts to solve the " Babeldom " of India.

Social and International Relations of Science.

IN a series of brilliant editorials in *Nature*, followed by a comprehensive Symposium[1] on Social and International Relations of Science, Sir Richard Gregory has been advocating that steps be taken to formulate the immediate purpose of science into a logical and constructive programme of work for the betterment of human relations and conditions of existence. The result of Sir Richard Gregory's action has been a wide awakening of consciousness among scientific workers that their interest in the promotion of social well-being and international cordiality is both profound and positive. Accordingly proposals for investigations of the social and public problems on an international basis have been favourably received by scientists in America and in most of the European countries. The outcome of this general movement has found expression in the establishment of a new Division by the British Association for the Social and International Relations of Science. We reproduce below the memorandum prepared for the consideration of the General Committee.

I. Proposal for the Establishment of a New Division.

At the present time a strong feeling exists that the social relations of science demand close and objective study. The question has been dealt with recently in the press and elsewhere. At an informal meeting of persons specially interested, it was stated that there is nothing in the constitution of the British Association to prevent the establishment of machinery within that organisation for the purpose desired. A resolution was thereupon addressed from this meeting to the Council of the Association, inviting the Association to establish a special department which would consider the social and international relations of science, by means of enquiry, publication, and the holding of meetings not necessarily confined to the annual meetings of the Association.

International relations were specified in this resolution primarily because of the deep interest of the American Association for the Advancement of Science in the subject. Discussion is expected to take place between officers of the two Associations, during the present summer, on the best means for international co-operation.

The Council supported the proposal to establish an organisation for these purposes within the Association. They appointed a Committee to formulate a scheme for the working of such an organisation, to be presented to the General Committee at the Cambridge Meeting. It is thought that the organisation should work on lines in some respects different from those of a Section, and should not bear that title. The term Division is therefore recommended.

The purpose of the Division would be to further the objective study of the social relations of science. The problems with which it would deal would be concerned with the effects of advances in science on the well-being of the community, and, reciprocally, the effects of social conditions upon advances in science.

The Division would be worked by a Committee, nominated annually by the Council and appointed by the General Committee. The Council should have power to appoint additional members of the Committee during the year.

The Committee should embody the existing British Science Guild Committee of the Association, inasmuch as the Norman Lockyer, Alexander Pedler, and Radford Mather Lectures, now administered by that Committee, would appropriately come within the purview of the Division.

The President of the Association and the General Officers should be *ex-officio* members of the Committee. A Chairman of the Committee should be appointed for a fixed period of office. A fixed proportion of the ordinary members of the Committee should retire annually (as in the case of the Council) and should not be eligible for immediate re-election.

The functions of the Committee would be:

(*a*) To arrange meetings of the Division both at the time and place of the Annual Meetings of the Association, and elsewhere at other times, as invited or otherwise arranged; to appoint speakers, and to accept or reject communications offered to the Division.

(*b*) To furnish material for the information of the public.

(*c*) To co-ordinate work dealing with the social relations of science, both at home and abroad.

(*d*) To be prepared to act in a consultative capacity and to supply information, and to that end to establish relations with organisations and persons engaged in practical administration.

(For the furtherance of the above objects, the Committee, immediately upon the establishment of the Division, should issue an announcement thereof, together with a reasoned statement of its aims, to institutions and other organisations and individuals known or likely to be interested in its work.)

(*e*) To set up sub-committees for executive purposes, or for research, enquiry, or co-ordination. If any such sub-committee should require a grant of money for its work, the Committee should be empowered to apply for such grant to the General Committee or the Council in accordance with the usual procedure relating to research committees.

(*f*) To maintain close relations with the Sections of the Association and their Organising Committees. In particular, there may be imagined subjects which two or more Sections might be

[1] *Nature*, Saturday, April 23, 1938, **141**, No. 3573.

disposed to recommend to the Division for discussion, in lieu of arranging joint meetings of the Sections. The Committee of the Division, on its part, should be enabled to invite the advice of the sectional organisations on all appropriate questions. The Organising Sectional Committees should be kept regularly informed of the activities of the Division.

The Committee should meet regularly throughout the year, at intervals determined by itself, and in particular it should hold a meeting at or near the time of the joint meetings of Organising Sectional Committees in January, in order to assure the relations with the Sections referred to above.

The Committee should report to the Council as and when necessary, and annually through the Council to the General Committee.

II. Proposal for a Quarterly Report.

In November 1937 the Council directed the General Officers to consider and report upon the format and printing of the Report of the Association. Subsequently, the Committee which was appointed to formulate a scheme for the new Division referred to above was instructed also to consider and report upon the whole question of publication by the Association.

The Committee, after considering various schemes in detail, recommend that as from the year 1939–40 the Annual Volume should be superseded by a Quarterly Report. The Annual volume following the Cambridge Meeting would thus be the last of its series.

The principal considerations which have led the Committee to make this recommendation are as follows:

Quarterly publication should go far to overcome the widespread belief that the British Association is inactive except during its annual meeting. The fact that it now administers the Norman Lockyer, Alexander Pedler, and Radford Mather Lectures (which are given at times and places other than those of the annual meetings) points to the desirability of publication at less than annual intervals; and the establishment of the new Division on the lines recommended would strongly reinforce this argument.

Quarterly publication would provide the means of keeping members and the public informed as to the activities of the Association, as an annual volume cannot. Quarterly publication should achieve a wider circulation than the annual volume does for individual communications which call for a wider publicity than they receive by inclusion in an annual volume.

It is recommended that the Quarterly should appear in October, January, April and July. The size proposed is royal octavo (approximately 10 × 6¼ in.). It is suggested that the title *The Advancement of Science* should be transferred to the Quarterly from the present publication which bears that name and contains the presidential address given at the annual meeting. In substitution for the publication of all these addresses together, it is proposed to issue individual addresses separately, at the time of the meeting.

The bulk of the material made available from the annual meeting would appear in the October and January numbers. There should, however, be the fullest possible measure of elasticity. This consideration might be expected to apply especially to the reports of research committees, for which delayed publication is sometimes found desirable; or on the other hand publication in advance of the meeting at which a particular research is to be discussed might be allowed at the discretion of the appropriate Organising Sectional Committee.

It is considered that the Journal of Sectional Transactions, as at present issued at the annual meeting and subsequently incorporated in the Annual Report, is of little value as a permanent record. It is proposed that the present Programme and Timetable should include the programme of each Section separately (as the Journal does now), with abstracts of the briefest possible nature, or none where titles of communications would suffice alone. The transactions of the Sections should be reported in the Quarterly in narrative form, and so far as finance would allow there should be additional opportunity for publication *in extenso* or full abstract, and for the reporting of discussions.

No changes in the terms of membership subscription are recommended; life members and annual members now entitled to receive the Annual Report would receive the Quarterly. The price of 3*s.* 6*d.* per part is recommended for non-subscribers.

The Quarterly should be marketed by arrangement with a publishing firm.

The division into quarterly parts would in itself cost little more than the annual volume, even allowing for improvement of the format. Additional matter for publication, however, would be expected from the new Division and from more effective reporting of the work of the Sections. The establishment of the new Division would increase clerical work in the office. On these considerations it has been estimated that the proposals here made might involve the Association in an additional annual expenditure of £400–500 in a few years' time; and in this event a temporary draft upon capital would be necessary.

It is hoped, however, that such additional expenditure would be offset by increased sales of the Quarterly and reports of the Presidential Addresses, as against those of the Annual Volume and the present *Advancement of Science*, and also by receipts from advertisements in the Quarterly. Moreover, the establishment of the new Division and the publication of a Quarterly are both measures which should help to increase the membership of the Association.

Meine geophysikalischen Arbeiten in Zentral—Asien.

von Prof. Dr. W. Filchner.

ZWECK meiner letzten drei Expeditionen nach USSR, China, Tibet und Indien war die magnetische Erforschung eine der bisher—im magnetischen Sinne—unbekannten Flecken der Erde. Er umfasst ein Gebiet innerhalb: Pamir, Himalaya, Dsungarei und Schanghai. Meine magnetischen Arbeiten haben sich nur mit der Erforschung des Baues und der Bewegungen der Erdkruste befasst.

Meinen magnetischen Arbeiten lag ein peinlich genau ausgearbeitetes Messprogramm zugrunde, zu dessen Durchführung besonders die zwei letzten Expeditionen nötig waren, eine in den Jahren 1926 bis 1928 und eine 1934 bis 1938.

Auf der ersten Expedition habe ich eine Messkette von Taschkent aus über Kuldscha —Ti-hua—Hami—Su-tschou — Lantschou — Küke-nôr—Tang-la nach Nag-tschu-ka (etwa 200 km. nördlich Lhassa) gelegt und von hier aus über Schen-ssa-dsong-Gartok nach Leh. Auf dieser Messkette folgen die ermagnetischen Stationen in Abständen von 20 bis 30 km. Von jeder Station musste die astronomische Position bestimmt werden und im Anschluss daran das Azimut. An den somit festgelegten astronomischen Fixpunkten wurden folgende magnetischen Elemente mit dem grossen magnetischen Theodoliten festgelegt: Deklination, Horizontal-Intensität und Vertikal-Intensität. Auch wurden täglich die Schwingungen durchgeführt. Alle 100 bis 200 km. wurde mit Hilfe des grossen magnetischen Theodoliten, eines Erdinduktors und eines Galvanometers die Inklination, etwa alle 70 km. würden die Konstanten bestimmt. Alle 100 km. wurden hierbei zwei Ablenkungsmagnete benutzt.

Im ganzen habe ich auf der erwähnten Strecke 157 magnetische Stationen errichtet. Die Messung auf einer Station dauerte bei günstigen Verhältnissen etwa 3, bei ungünstigen bis zu 20 Stunden.

Durch diese Messungen konnte gerade im Küke-nôr-Gebiet das theoretisch so interessante Umschlagen der Variation der Horizontal-Intensität erkannt werden.

An einigen Punkten, auf denen schon früher von mir oder anderen Forschern erdmagnetische Beobachtungen ausgeführt worde waren, habe ich Wiederholungsmessungen gemacht, die der Bestimmung der Schwankung der Säkular-Variation, d.i., der Prüfung der fortschreitenden Veränderung der magnetischen Elemente zugute kommen. Meine Beobachtungen sind die ersten, in so umfangreicher Weise, in Zentral-Asien ausgeführten. Damit die Messpunkte jederzeit wieder aufgefunden werden und auf ihnen die magnetischen Messungen wiederholt werden können, habe ich von jedem Messpunkt (Station) und Umgebung eine Ortsskizze angefertigt.

Die unbedingte Voraussetzung für die Exaktheit der Messungen war die Prüfung und Eichung der Instrumente in der Form von Anschlussmessungen in Potsdam bzw. Niemegk und in Dehra-Dun in der Survey of India, wobei mir folgende Herren der Survey of India stets die weitestgehende Unterstützung hatten zuteil werden lassen: Der Direktor der Survey of India Colonel C. M. Thompson, Major G. Bomford, R. E., Dennis Kingston Rennick, M.B.E. Rai Sahib R. B. Mathur, B.A., und Shiam Narain, B.Sc.

Die Beobachtungsergebnisse meiner ersten Expedition, deren Verlauf bereits angegeben wurde, liegen heute bereits ausgearbeitet vor. Sie lassen erkennen, dass das Küke-nôr-Gebiet von der Null-Isogone geschnitten wird, dass es also eine Zone ist, in der die Deklination aus der östlichen Abweichung in die westliche umschlägt. Sie lassen weiter den mit Resultaten aus den Schweremessungen übereinstimmenden Schluss zu, dass das magnetitreiche Urgebirge in Tibet in grosser Tiefe liegt.

Die etwa 6000 km. lange Wegstrecke meiner ersten Expedition zeigt die Form einer Schleife und fixiert in dieser Form, kathographisch gedeutet, nur eine *lineare Verteilung* der erdmagnetischen Ergebnisse.

Um aber die erdmagnetische Situation Zentral-Asiens *flächenmässig* zu erfassen und die magnetische Erschliessung eines weiten Bereichs in grossen Zügen zu vollenden, unternahm ich in den Jahren 1934 bis 1938 eine zweite Expedition, die den Zweck verfolgte, mitten durch die ellypsenartige

Schleife der ersten Expedition, und zwar von Lan-tschau aus entlang der Längsachse O–W, eine Messehne westwärts entlang Kükenōr, Tsaidam, Ajak-kum nöl, Tschertschen bis nach Chotan zu legen, hier Anschluss an die magnetischen Beobachtungen Piewzoffs zu finden und diese Messkette von hier aus bis nach Leh zu verlängern. Auch bei dieser Expedition sind alle Instrumente vorher und nachher mit den Normalapparaten in Potsdam bzw. Niemegk und Dehra-Dun verglichen worden. Diese zweite Expedition war auf zwei Jahre geplant. Es wurden aber vier Jahre daraus, da sich mir die grossen und kleinen Schicksale, Zwischenfälle, Widerstände und Verwirrungen mit weit grösserer Treue und Beharrlichkeit an die Fersen hefteten, als ich willens war, gelassen zu ertragen.

Auf diesser zweiten Expedition habe ich an Stellen, wo ich mich etwas länger aufhalten konnte, auch die Schmidt'sche Feldwaage benutzt und mit ihr kleinere Gebiete mit einem Netz von Feldwaagemessungen überzogen. Dauernd sind die verschiedenen Magnete und Kompensationsmagnete untereinander verglichen worden und ab und zu sogar auf den Schienen des magnetischen Theodoliten nachgemessen worden.

Durch die Messungen der zweiten Expedition ist erreicht worden, dass die lineare Verteilung der erdmagnetischen Ergebnisse zu einer *flächenhaften* erweitert werden konnten und dass es somit jetzt möglich geworden ist, vom Gebiet innerhalb der Plätze Taschkent—Ti-hua–Lan-tschau—Lhassa eine *magnetische Karte* zu entwerfen. Die magnetischen Ergebnisse dieser beiden Expeditionen werden aber auch praktisch von Nutzen sein für Vorarbeiten für Eisenbahn-, Strassen- und Wasserbau, für Bodenforschung, sowie für das Flugwesen, die Ingenieurwissenschaft und den Bergbau.

Neben diesen magnetischen Arbeiten habe ich auf Bitten der Aero Survey des chinesischen Generalstabs in Nanking auch noch Arbeiten ausgeführt, die der Luftbildmessung der von mir durchreisten Gebiete zugute kommen sollen. Es sollten an die von mir fixierten astronomischen Punkte bzw. an das Azimut dieser Punkte alle markanten Geländepunkte der Umgebung angeschlossen werden und ausserdem vom Stationspunkt und dessen Umgebung jeweils eine Ortsskizze hergestellt werden. Dadurch würde man später sowohl die von mir astronomisch bestimmten Punkte, als auch die an sie angeschlossenen markanten Geländeobjekte leicht auffinden können. Die von mir geschaffenen Fixpunkte könnten also leicht in die Flugbildaufnahmen übertragen werden und die letzteren damit in einem festen astronomischen Rahmen verankert werden.

Die Genauigkeit meiner astronomischen Beobachtungen ist eine für den angestrebten Zweck durchaus hinreichende. Die Breiten der auf der zweiten Expedition gewonnenen Werte stimmen auf Bruchteile einer Bogenminute und mit Hilfe eines in Zi-ka-wei in der Jesuitensternwarte gebauten Kurzwellenempfängers gewonnen Längen haben mindastens eine Bogenminute Genauigkeit. Es standen mir sechs Chronometer und zwei Stoppuhren zur Verfügung, die im allgemeinen zweimal täglich mit Nauen, oder Moskau, Buenos Aires oder Cavite, dem Kriegshafen von USA, verglichen wurden. Von den Chronometern hatten zwei 1/2-Sekundenschlag. Die genauen Ortsbestimmungen sind für die Kartographie Zentral-Asiens wichtig.

Im ganzen habe ich auf den beiden letzten Expeditionen in Zentral-Asien etwa *520* magnetische Stationen geschaffen. Von diesen entfallen auf die letzte Expedition etwa 360 Stationen. Die Berechnung der erdmagnetischen Ergebnisse liegt in den Händen von Prof. Dr. O. Venske, Potsdam und diejenige des astronomischen Teils in den Händen von Prof. Dr. E. Przybyllok, Königsberg. Spätestens in zwei Jahren dürften die ganzen Messungen berechnet sein.

[The object of Prof. Filchner's last expedition to USSR, China, Tibet and India was the magnetic investigation of a region so far not magnetically surveyed. It includes the regions between Pamir, Himalaya, Sungaria and Shanghai.

On the first expedition during 1926–28, Prof. Filchner established a chain of observation posts from Tashkent to Nagchu (about 200 km. north of Lhasa) through Kulja, Tihua, Hami, Suchow, Lanchow, Kokonor and Tangla. On this chain the stations lay at distances of 20 to 30 km. The astronomical position of each station was determined and the azimuth was related to this. The following magnetic elements—declination, horizontal intensity and vertical intensity—were determined by means of a large magnetic theodolite. Oscillations were also observed daily. After every 100 to 200 km. the inclination was determined with the large magnetic theodolite and an earth inductor and galvanometer, the constants being determined every 70 km. After every 100 km., two deflecting magnets were used for this purpose.

The stations established during the first expedition

were *linearly* distributed along a loop. In order to complete a survey of the whole *area*, a second expedition was undertaken during 1934–38, with the object of establishing a series of posts on an East-West axis from Lanchow along Kokonor, Tsaidam, Ajak-kumnöl and Cherchen to Chotan, and connecting up here with the magnetic observations of Piewzoff and extending this line up to Leh. This time, as in the previous expedition, the instruments were compared with standard ones at Potsdam, Niemegk and Dehra Dun before and after the Survey. This expedition was planned for two years but on account of a number of difficulties it actually lasted four years.

On the whole 520 stations have been established, of which about 360 were founded during the recent expedition. The reduction of the magnetic observations is in the hands of Prof. Dr. O. Venske of Potsdam, and that of the astronomical observations has been taken up by Prof. Dr. E. Przbyllok of Konigsberg. All the observations may be reduced, at the latest, within two years.]

Donnan Equilibria in Biological Processes.

By K. R. Dixit,

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(Received June 26, 1938.)

Introduction.

THE expression 'Donnan Equilibrium' or 'Membrane Equilibrium' is used to represent the state of thermodynamical or statistical equilibrium, between two homogeneous fluids separated by a membrane. The two fluids are at the same temperature and the membrane is permeable for some molecules or ions present in the two fluids but not for all. In other words, the Donnan Equilibrium deals with a system in which a mass of solvent is divided by a membrane into two phases, both of which contain *e.g.*, diffusible ions, and one of which contains a non-diffusible ion. The presence of the non-diffusible ions or molecules leads to an unequal distribution of the diffusible ions or molecules on the two sides of the membrane.

The study of the membrane equilibria is a well-known branch of physical chemistry. We get osmotic equilibria if the membrane is permeable only by the solvent. The conditions of this equilibria were studied by Willard Gibbs[1] in 1878, and according to him the chemical potential of the solvent must be the same on the two sides of the membrane. Gibbs' application of thermodynamics to the membrane equilibria, however, remained unnoticed for a very long time. In the year 1890, soon after the ionic theory of Arrhenius was known, William Ostwald[2] suggested the study of two solutions separated by a membrane, which allows some ions, but not all ions to pass through. In 1910, Donnan and Harris[3] made a detailed examination of the molecular state of congo red in aqueous solution by means of measurements of osmotic pressure. They found unequal distribution of sodium and chlorine ions, and suggested that this behaviour may be explained with the help of thermodynamics. The thermodynamical theory of membrane equilibria was first developed by Donnan[4] in 1911. In this form the theory was applicable to dilute solutions in the ideal form. More recently Hückel[5] and Donnan and Guggenheim[6,7] have revised the theory to make it applicable to imperfect solutions of electrolytes and non-electrolytes. This equilibrium theory has been re-examined by Gatty[8] in terms of the number of degrees of freedom of systems containing any number of chemical components and containing any number of membranes. The statistical theory of such membrane equilibria has been worked out by Ganguli.[9]

The theory of Donnan has been applied to very many special problems, and we shall mention here only a few of such

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[1] Gibbs, *Collected Works*, 1928, **1**, 83.

[2] W. Ostwald, *Zeit. Physik. Chem.*, 1890, **6**, 71.

[3] Donnan and Harris, *Journ. Chem. Soc.*, 1911, **99**, 1554.

[4] Donnan, *Zeit. Elektrochem.*, 1911, **17**, 572.

[5] Hückel, *Kolloid Zeit.*, 1925, **36**, 204.

[6] Donnan and Guggenheim, *Zeit. Physik. Chem.*, (A), 1932, **162**, 346.

[7] Donnan, *ibid.*, 1934, **168**, 369.

[8] Gatty, *Phil. Mag.*, 1934, **18**, 273.

[9] A. Ganguli, *Kolloid. Zeit.*, 1934, **67**, 304.

applications. Thus Liu[10, 11] has discussed the theory in conjunction with the activity co-efficient of electrolytic solutions. The effect of adsorption of solute and solvent by the membrane on the direction of osmosis of systems not in equilibrium, and a classification of such systems has been given by Schreinemakers and Werre.[12] They have also discussed the properties of mosaic membranes whose permeability varies from point to point. The latter effect and its relationship to negative osmosis has been discovered by Söllner,[13] while the properties of membranes that are capable of doing work have been discussed by Straub.[14]

Now if we try to apply the theory of Donnan to biological processes we are confronted with a difficulty. All the biological processes are characterised by life and the living cell is really a physico-chemical transformer which assimilates various substances, and maintains itself in its dynamically stationary state. But any system at constant temperature obeying the laws of thermodynamics must tend towards that configuration in which its free energy is minimum. That is, a system cannot maintain its dynamically stationary state and at the same time obey the laws of thermodynamical equilibrium, or only non-living systems can be in a state of thermodynamical equilibrium. It would appear from this that it is not permissible to apply the theory of Donnan to the living cells. There is, however, a loop-hole in this argument and we can argue, that all living organisms are not living to the same extent, that is, do not possess the same amount of free chemical energy. Some parts of an organism may possess an amount of free chemical energy, which is equal to that which that part would be required to possess if the system obeyed the laws of thermodynamics. The theory of the membrane equilibria is strictly applicable only to those parts of a living organism where the free chemical energy is a minimum. The greater the deviation of the actual free chemical energy of the system from the minimum chemical energy, the greater would be the inapplicability of the laws of Donnan to such a system. But even in such extreme cases we can say that the theory of Donnan equilibria if applied to biological processes is likely to give us some indication of the actual physico-chemical changes that are brought about in an organism.

Warburg[15] was the first to apply the theory of Donnan equilibria to red blood corpuscles. Considerable progress has been made in this direction by L. J. Henderson,[16] D. D. van Slyke[17] and their collaborators. Donnan's method has also been applied with success to various other biological processes. In this article we shall first consider the thermodynamics of the Donnan equilibria and then we shall turn our attention to some typical biological applications of the same. We shall also try to get a picture of the physico-chemical processes which must be accompanying the biological processes.

Osmotic Equilibrium.[18]

Membrane equilibria arise when two solutions are separated by a membrane which is permeable for some of the components but not for all. The most familiar case is that of an ordinary osmotic equilibrium where there are two components, the membrane being permeable for one (called the solvent) but not for the other (called the solute). In the simplest case of this type of equilibrium, the solution is present on one side of the membrane, the pure solvent on the other, *i.e.*,

Solution	Pure Solvent
Pressure $= P_1$	Pressure $= P_2$
(1)	(2)

If the hydrostatic pressures P_1 and P_2 (supposed uniform on both sides) are equal, the solvent diffuses from (2) to (1) and the solution phase (1) swells in volume.

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[10] Liu, *Kolloid. Zeit.*, 1931, **57**, 139 and 285.

[11] Liu, *ibid.*, 1932, **58**, 144.

[12] Schreinemakers and Werre, *Proc. Aka. Amsterdam*, 1932, **35**, 42 and 162.

[13] Söllner, *Biochem. Zeit.*, 1932, **244**, 370.

[14] Straub, *Chem. Weekblad*, 1930, **27**, 672.

[15] E. Warburg, *Biochem. Journ.*, 1922, **16**, 153.

[16] L. J. Henderson, *Blood, a Study in General Physiology*, Dresden, 1932.

[17] D. D. van Slyke, *Factors affecting the Distribution of Electrolytes, Water and Gases in the Animal Body*, London, 1924.

[18] F. G. Donnan, *Journ. International Soc. Leather Trades' Chemists*, 1933, **17**, 136.

For any given temperature this osmotic movement of the solvent molecules can be prevented by sufficiently increasing P_1 or lowering P_2. For equilibrium if the phase (1) can be treated as an ideal solution,

$$P_1 - P_2 = \frac{RT}{V_0} \log \frac{1}{N_0} \quad .. \quad .. \quad (1)$$

where N_0 = mol. fraction of the solvent in the solution (1) and V_0 = increase in volume of an infinite mass of solution on adding to it one mol. of the solvent. If the solution is an ideal one (as supposed) and if we neglect the compressibility of solution and solvent, then we can state that V_0 is simply the volume of one mol. of the pure liquid solvent at the temperature T. The pressure difference $\pi = P_1 - P_2$ is called the osmotic pressure of (1) against the pure solvent. We may write the foregoing equation in the form

$$\pi = -\frac{RT}{V_0} \log (1 - N_s) \quad .. \quad .. \quad (2)$$

where N_s = mol. fraction of the solute in the solution (1) at equilibrium, since $N_0 + N_s = 1$. This equation is valid for all concentrations of an ideal solution. If the solution is dilute enough to justify the neglect of higher powers of the fraction N_s in the series expansion of the logarithmic term $\log (1 - N_s)$, then we may write

$$\pi = \frac{RT}{V_0} N_s = \frac{RT}{V_0} \frac{n_s}{n_0 + n_s} \quad .. \quad .. \quad (3)$$

where n_s and n_0 are the mol. numbers of solute and solvent respectively in solution (1) at equilibrium. If we may neglect n_s in comparison with n_0 then we obtain

$$\pi = RT \frac{n_s}{n_0 V_0} \quad .. \quad .. \quad .. \quad (4)$$

where $n_0 V_0$ = volume of the solvent employed. We may employ this equation as it stands or introduce molar volume concentrations.

If the solutions are not ideal, we must write the original equation in the form

$$\pi = \frac{RT}{V_0} \log \frac{1}{N_0 f_0} \quad .. \quad .. \quad .. \quad (5)$$

where f_0 = the activity coefficient of the solvent. We may also write this equation in the form

$$\pi = \frac{gRT}{V_0} \log \frac{1}{N_0} \quad .. \quad .. \quad .. \quad (6)$$

where g is called the osmotic coefficient of the solution.

In general when a membrane equilibrium occurs, some of the solute components, *i.e.*, the ones for which the membrane is permeable will be present in the solutions on both sides of the membrane.

Thermodynamical Equilibrium in Simple Systems.[19-22]

The theory of Donnan in its original form[4] is applicable only to dilute ideal solutions of dissociated electrolytes. (The solutions are said to be ideal when the interaction between the molecules of the solute can be neglected, further the interaction between the molecules of the solute and the solvent is independent of the concentration.) In this simple form the theory has been applied to a large number of biological processes. Let us first consider the two types of biological processes, those that are likely to show thermodynamical equilibria, and those which can show chemical equilibria.

According to the laws of diffusion, such substances as salts and sugars, which are soluble in water and are absorbed by the cell, must continue to enter the cell until the concentration of each substance becomes equal, both outside and inside the cell. As the plant usually obtains rather dilute solutions of nutritive substances, it is evident that their entrance into and accumulation within the cell require special conditions. A most important pre-requisite is the chemical change of the absorbed substances. For instance, when carbohydrates are stored in the tubers of the potato, the sugar obtained by the cells from the leaves is transferred directly into starch, which is insoluble in water. The concentration of sugar in the cells of the growing tuber is therefore extremely low and does not impede the diffusion of new amounts of sugar. The same is observed in ripening oil-bearing seeds. The only difference in this case is

[19] F. G. Donnan, *Kolloid. Zeit.*, 1932, **61**, 160.

[20] T. R. Bolam, *Kolloid. Beihefte*, 1934, **39**, 139.

[21] Padoa and Tedeshi, *Biochem. Zeit.*, 1933, **266**, 452.

[22] Maximow, *Text-book of Plant Physiology*, McGraw Hill, 1930, 119.

that the fats are now accumulated at the expense of the soluble carbo-hydrates. Protein compounds are formed from amino acids and so on. As a general rule, the substances entering the cell are subject to chemical transformation which assures their uninterrupted absorption.

This general mechanism of the absorption and accumulation of substances in the cell, however, does not always hold true. There are cases when solute substances accumulate in great quantity, and remain in the same state in which they are when entering the cell, for example, in the bulb of the common onion, are stored considerable amounts of glucose. In pigweed and other plants much potassium nitrate accumulates. At the present time, the explanation of these phenomena is sought in the so-called membrane equilibria of Donnan.

If a membraneous sac impermeable to colloids containing a readily ionisable salt, one of whose ions is of a colloidal character, such as sodium proteinate—a sodium salt in which the rôle of an acid is played by some protein—is immersed in water, the sodium ions though able to pass through the membrane, will not diffuse out of the sac, being retained by the electrostatic attraction of anions and cations. If some easily penetrating salt is added to water, for instance sodium chloride, then in the process of osmosis the Na^+ and Cl^- ions will diffuse through the septum and finally there will be established an equilibrium.

To apply thermodynamics to these processess, let us consider the solution of a salt NaR, separated from the solution of NaCl by a membrane, and let us suppose that the membrane is permeable for all particles except the anion R^- and the undissociated salt NaR. The initial and the final states may be represented diagrammatically as follows. The vertical line represents the membrane.

Initial State.

Na^+	R^- (Proteinate)	Na^+	Cl^-
C_1	C_1	C_2	C_2
(concentrations of the ions)			
(1)		(2)	

Final State.

Na^+	R^-	Cl^-	Na^+	Cl^-
$C_1 + X$	C_1	X	$C_2 - X$	$C_2 - X$
	(1)		(2)	

The resultant electrical charge on each side of the membrane must be zero and hence

$$(Na^+)_1 = (Cl^-)_1 + (R^-)_1$$
$$\text{and } (Na^+)_2 = (Cl^-)_2$$

Further, as the system is in equilibrium, the work done in taking equal quantities of Na^+ and Cl^- ions in the same direction must be equal, hence

$$dn\ RT \log \frac{(Na^+)_2}{(Na^+)_1} + dn\ RT \log \frac{(Cl^-)_2}{(Cl^-)_1} = 0 \quad (7)$$

Therefore in the state of equilibrium

$$(Na^+)_1 \times (Cl^-)_1 = (Na^+)_2 \times (Cl^-)_2$$

This unequal distribution of the charged particles gives rise to a difference of potential E on the two sides of the membrane,

$$E = \frac{RT}{F} \log \frac{(Na^+)_2}{(Na^+)_1} \quad .. \quad .. \quad (8)$$

This difference of potential which may be supposed to be localised on the membrane is called the membrane potential. F = Faraday's equivalent in volt-coulombs. This difference of potential can also be expressed in terms of Cl^- ions, and we get

$$E = \frac{RT}{F} \log \frac{(Cl^-)_1}{(Cl^-)_2} \quad .. \quad .. \quad .. (8\,a)$$

The expression for E in terms of any positive ions will be similar to 8, while any negative ions will be similar to 8*a*. Hence we get

$$\frac{(A^+)_1}{(A^+)_2} = \frac{(B^+)_1}{(B^+)_2} = \frac{(C^-)_2}{(C^-)_1} = \frac{(D^-)_2}{(D^-)_1} \quad .. \quad (9)$$

Similarly, by applying the equation 7 we get for doubly charged positive ions, if simultaneously present with singly charged sodium ions, the relation

$$\frac{(Ca^{++})_1}{(Ca^{++})_2} = \frac{(Na^+)_1^2}{(Na^+)_2^2} \quad .. \quad .. \quad .. (9\,a)$$

We can also express the membrane potential E in terms of the corresponding pH values

$$E = \frac{RT}{F} \log \frac{(Na^+)_2}{(Na^+)_1} = \frac{RT}{F} (pH_1 - pH_2)$$
$$.. \quad (10)$$

Let us apply these considerations to the case of NaR and NaCl which has been already represented by a diagram. According to Donnan, at equilibrium the products of the concentrations of the diffusible ions must be equal on both sides of the septum. Then we get

$$(C_1 + X)\,X = (C_2 - X)^2$$

From this equation may be calculated the relation between the ions of sodium and of chlorine on both sides of the septum. This calculation shows that higher the concentrations of sodium proteinate in comparison to the concentration of sodium chloride, the less complete will be the equalisation of the concentrations of NaCl in the surrounding solution and the osmometer, and the more it is retained in the surrounding liquid. Let us give some figures illustrating the membrane equilibria of Donnan.

TABLE I.

Initial concentrations		Final concentrations NaCl	
NaR	NaCl	Inner solution	Outer solution
0·01	1	0·497	0·503
0·1	1	0·476	0·524
1·0	1	0·33	0·66
10	1	0·083	0·917
100	1	0·01	0·99

These figures show that the large amount of sodium proteinate makes the membrane appear as if impermeable to NaCl and this salt ceases to penetrate into the sac of the osmometer.

If a salt with another cation than the one connected with the proteinate within the osmometer is taken, for instance KCl instead of NaCl, another correlation will be obtained. As before this can be represented diagrammatically.

Initial State.

Na^+	R^-	K^+	Cl^-
C_1	C_1	C_2	C_2

Final State.

Na^+	K^+	Cl^-	R^-	K^+	Na^+	Cl^-
C_1-Z	X	Y	C_1	C_2-X	Z	C_2-Y

The concentration X, Y and Z are connected by the equation $Z = X - Y$. Further, the conditions of equilibrium give us the following equations :—

$$\frac{C_1 - (x - y)}{x - y} = \frac{x}{C_2 - x} \quad .. \quad .. \quad (a)$$

$$\frac{C_1 - (x - y)}{x - y} = \frac{C_2 - y}{y} \quad .. \quad .. \quad (b)$$

hence $$\frac{x}{C_2 - x} = \frac{C_2 - y}{y}$$

or $$x + y = C_2$$

substituting in a and b we get

$$x = \frac{(C_1 + C_2)\,C_2}{C_1 + 2C_2}$$

$$y = \frac{C_2^2}{C_1 + 2C_2}$$

or $$\frac{(Na^+)_1}{(Na^+)_2} = \frac{(K^+)_1}{(K^+)_2} = \frac{(Cl^-)_2}{(Cl^-)_1} = \frac{C_1 + C_2}{C_2}$$

The cations of this electrolyte KCl introduced into the surrounding solution, will be attracted towards the interior of the membrane by the anion of the protein. The anion on the contrary will be forced outwards. Donnan illustrates this relation by the following table :—

Table II.

Initial concentration		Final concentration					
		K		Na		Cl	
NaR	KCl	Inside	Outsibe	Inside	Outside	Inside	Outside
0·1	1	0·5	0·5	0·05	0·05	0·5	0·5
1·0	1	0·66	0·33	0·66	0·33	0·33	0·66
10	1	0·90	0·10	9·2	0·8	0·10	0·90
100	1	0·99	0·01	99·0	1·0	0·01	0·99

With the great abundance of the colloidal ions within the osmometer, if compared to

the concentration of salts in the surrounding liquid, for instance 100 : 1 in the last line of our table, the almost complete disappearance of K (99 per cent. of the original amount) from the surrounding medium and its accumulation within the osmometer may be observed. At the same time the almost complete expulsion of the Cl ion from the osmometer is observed, in spite of the fact that both ions pass readily through the membrane and enter into no chemical reactions within the osmometer.

In an analogous way may be explained the accumulation of different kinds of ions in the plant cells containing a considerable amount of protein substances which show the properties of ampholytes, that is, substances which act as weak acids and weak bases and therefore are able to induce the accumulation of cations as well as of anions. As the composition of the colloidal substances in the cells changes continually, quantitatively as well as qualitatively, the conditions of Donnan equilibria prove very complicated in them. The protoplasma being impermeable not only to the colloids but also to many electrolytes, for instance to organic acids, these combinations too may determine the conditions for the establishment of Donnan's equilibrium between the cell and the surrounding medium, and may promote the accumulation in the plant of many anions and cations in much higher concentrations than are found in the surrounding medium, for instance in the soil solution. At the present time, attempts are being made to reconstruct the whole theory as to the entrance of substances from the soil into the roots on the basis of the conditions discovered by Donnan. This necessitates, however, an extension of Donnan's simple theory, to non-ideal solutions.

The Exact Theory of Membrane Equilibrium.[6, 7, 23]

The theory of membrane equilibrium in its most general form was established by Gibbs. He showed that if a fluid mass be divided into two parts by a rigid diaphragm, permeable by some of the components but impermeable by others, the conditions that are necessary for equilibrium can be stated as follows. In the first place, the absolute temperature T′ in the fluid phase designated L′ must be the same as the temperature T″ in the phase L″ on the opposite side of the membrane. In the second place, the partial free energy or chemical potential of each one of the substances which are free to diffuse accross the membrane must be the same in both phases. The potentials and other properties of the substances designated S_1, S_2, $S_3 \cdots S_r$ are distinguished by subscripts as in formula 11.

$$\mu_1' = \mu_1'', \qquad \mu_2' = \mu_2'' \qquad \cdots (11)$$

where μ_1' = the chemical potential of the substance S_1 in the phase L′. Such equations, applicable to all substances that can diffuse across the membrane, give the criteria for an exact thermodynamical equilibrium.

In the case of membrane equilibrium the hydrostatic pressures P_1 and P_2 on the two sides of the membrane are not necessarily equal, the same is the case with the potentials of the substances which cannot pass through the membrane.

Gibbs' conditions for equilibrium have been expressed by Donnan and Guggenheim[6,7] in a form which is easily applicable to experimental investigation.

$$\mu_1 = \mu_1^*(T) + Pv_1^*(1 - \tfrac{1}{2}K_1P) + RT \log N_1 f_1 \quad (12)$$

where $\mu_1^*(T)$ = a constant at a constant temperature, which need not be determined. P = the pressure in the solution. v_1^* = the volume occupied by 1 mol. of S_1 in a very dilute solution at zero pressure. K_1 = the compressibility of S_1 in very dilute solutions. (The equation 12 is subject to a small correction for the effects of changes in compressibility at very high pressures.) R = the gas constant. T = the absolute temperature. N_1 = molar fraction = mols. of S_1 divided by the total number of mols. in the solution. f_1 = the activity coefficient which may be a measure of the deviations from the ideal solution laws. The symbol f_1 denotes the activity coefficient at pressure P and f'_1 at pressure P′.

Donnan and Guggenheim obtained the equation 13 from 11 and 12, eliminating the constant term $\mu_1^*(T)$ which must be the same in both phases.

$$P'v_1^*(1 - \tfrac{1}{2}K_1P') + RT \log N_1'f_1' = RT \log N_1''f_1'' + P''v_1^*(1 - \tfrac{1}{2}K_1P''). \quad (13)$$

[23] G. S. Adair, *Trans. Farad. Soc.*, 1937, **33**, 1106.

They suggested an abbreviated notation in which $[v_1]$ represents

$$v_1^* [1 - \tfrac{1}{2}K_1 (P' + P'')]$$

the volume at the mean pressure $\frac{P' + P''}{2}$.

In order to allow for the changes in compressibility with increasing pressure, the symbol $[v_1]$ is here defined by the formula

$$[v_1] = \left(\int v_1 dP\right) / (P' - P'') \quad .. \quad (14)$$

where v_1 denotes the volume occupied by 1 mol. of S_1 in a very dilute solution. With this definition the equations 15 to 21 are exact.

$$(P' - P'') [v_1] + RT \log N'_1 f'_1 = RT \log N_1'' f_1'' \quad .. \quad (15)$$

If the substance S_1 be solvent water, it may be more convenient to use osmotic coefficients g_1' and g_1'' as a measure of the deviations from the ideal solution laws.

$$(P' - P'') [v_1] + g_1' RT \log N_1' = g_1'' RT \log N_1'' \quad .. \quad (16)$$

Equations like 13 and 15 can be applied to any non-electrolyte that can diffuse across the membrane.

$$(P' - P'') [v_2] + RT \log N_2' f_2' = RT \log N_2'' f_2'' \quad .. \quad (17)$$

If we eliminate the pressures, using equations 15 and 17 we obtain the equation 18 given by Donnan and Guggenheim.

$$\frac{(N_2' f_2')}{(N_1' f_1')^r} = \frac{(N_2'' f_2'')}{(N_1'' f_1'')^r} \quad .. \quad .. \quad (18)$$

where $r = [v_2] / [v_1]$.

A slight modification of their treatment with special reference to systems in which the pressures can be determined with greater accuracy than the molar fractions is given by Adair.[23] With the abbreviation

$$h_1 = [v_1] (P' - P'') / RT \quad .. \quad (19)$$

the equation 15 may be restated in the form

$$N_1' f_1' e^{h_1} = N_1'' f_1''$$

where $e^{h_1} = 1 + h_1 + \frac{1}{2}h_1^2 + \cdots \quad (20)$

A similar formula can be applied to the substance S_2 and in a system where S_1 and S_2 can diffuse across the membrane we get

$$\frac{N_2' f_2' e^{h_2}}{N_1' f_1' e^{h_1}} = \frac{N_2'' f_2''}{N_1'' f_1''} \quad .. \quad .. \quad (21)$$

In practical applications of the theory of membrane equilibrium it is customary to use a simpler, but approximate formula

$$m_2' f_2' = m_2'' f_2'' \quad .. \quad (22)$$

where m_2 = the molality in aqueous solutions expressed in gram-mols of S_2 per 1000 grams water. The estimation of the errors due to the use of the approximate formula has been made by Adair, and his calculations show that although the error in investigations of the membrane equilibria, of small molecules, in systems where the pressure difference $P' - P''$ is small, can be disregarded, the exact formula will have to be used in the interpretation of experiments with membranes permeable by large molecules as, for example, in the ultrafiltration of proteins described by Elford,[24] and the work of Moran[25] on equilibria with gelatine gels and sodium chloride at pressures exceeding 2000 atmospheres.

The Membrane-Equilibrium of Ionised Electrolytes.

In a system where an acid, a base for a salt can diffuse across the membrane, the chemical potential of the electrolyte must be the same in both phases as stated in 11. If the electrolyte dissociates, yielding r_i ions of the species S_i and r_j ions of the species S_j, the diffusion of an ion is subject to the condition that an equivalent quantity of ions of opposite sign pass across the membrane in the same direction. The condition for equilibrium is

$$r_i \mu_i' + r_j \mu_j' = r_i \mu_i'' + r_j \mu_j'' \quad .. \quad (23)$$

we can compare this with $(Na^+)_1 \times (Cl^-)_1 = (Na^+)_2 \times (Cl^-)_2$ given by Donnan.

In a system where two ions of the same sign, S_i and S_k can diffuse across the membrane, we get the equation 24, since the possible variations dm_i' and dm_k' in the composition of the phase L′ are subject to the condition that

$$dm_i' / n_i = - dm_k' / n_k$$

$$\frac{\mu_i'}{n_i} - \frac{\mu_k'}{n_k} = \frac{\mu_i''}{n_i} - \frac{\mu_k''}{n_k} \quad .. \quad .. \quad (24)$$

or $(\mu_i' - \mu_i'')n_k = (\mu_k' - \mu_k'')n_i \quad .. \quad (25)$

In a system where two salts containing the ions S_i, S_j and S_k can diffuse across the membrane, equations 23 and 24 are both applicable, it is possible to restate these formulæ in terms of molar fractions, as in formula 19

$$(N_i' f_i' e^{h_i})^{r_k} (N_j' f_j' e^{h_j})^{r_j} = (N_i'' f_i'')^{r_k} (N_j'' f_j'')^{r_j} \quad .. \quad (26)$$

[24] Elford, *ibid.*, 1937, **33**, 1100.

[25] Moran, *Report of Food Investigation Board for* 1935, 20.

The activity coefficients of the individual ions can be replaced by $f\pm$, the mean activity coefficient. If the pressure difference $P' - P''$ be small, and f the activity coefficient of water be the same in both phases, we get the equation 27, which is applicable to a salt with two univalent ions

$$\frac{(f_\pm')^2}{(f_\pm'')^2} = \frac{m_{Na}'' \times m_{Cl}''}{m_{Na}' \times m_{Cl}'} \quad .. \quad .. \quad (27)$$

It appears that equation 27 is useful in considerations of the state of equilibrium between the blood and the aqueous humour discussed by Ridley[26] and by Davson, Duke-Elder and Benham.[27]

If the osmotic pressure be low and both of the ions be univalent, equation 27 is replaced by the simple but approximate equation 28.

$$\frac{m_i' f_i'}{m_k' f_k'} = \frac{m_i'' f_i''}{m_k'' f_k''} \quad .. \quad .. \quad .. \quad (28)$$

Membrane Potentials and the Potentials of Individual Ions.

From the thermodynamical point of view, no criterion for the equilibrium of an individual ion across the membrane is necessary because the possible variations in the state of the system are comprehended by equations 23 and 24 applicable to pairs of ions. Under certain conditions, it is, however, convenient to supplement these equations by another equation involving the potentials of the ion S_i in both phases L′ and L″ and the electrical potential difference $(E' - E'')$ between the phases.

$$\mu_i' = \mu_i'' - n_i F (E' - E'') = \mu_i'' - n_i' FE \quad (29)$$

F = Faraday's equivalent in volt-coulombs. $E = E' - E''$, n_i the valence of the ion of the species S_i is negative for anions. This formula is comparable with the approximate formula

$$pH' = pH'' - \frac{E}{0{\cdot}05416} \times \frac{273}{273 + t} \quad .. \quad (30)$$

used by Loeb[28] and by Adair and Adair.[29] The last mentioned authors correlate the membrane potentials and *p*H values, they also give a precise method for the measurement of membrane potentials with certain types of solutions containing proteins.

Membrane Equilibrium in Systems where the Composition of one Phase is Constant.

In studies on proteins, it is often desirable to investigate solutions containing a mixture of inorganic electrolytes. If the protein solution L′ be enclosed in a membrane permeable by all the components except the protein, in equilibrium with the dialysate L″ of constant temperature, pressure and composition, the properties of the system are determined by one independent variable, the concentration of the protein in L′, even if the number of diffusible substances be unlimited. Adair[30, 31] has shown that the potential of the protein, or the protein salt μ_{ps} is correlated with the observed osmotic pressure π and the volume V of solution per mol. of protein by the formula

$$d\mu_{ps} = V d\pi \quad .. \quad (31)$$

Some special cases of this type of equilibria have been considered by Adair. For example, he gives the relationship between osmotic pressures, protein concentrations, molecular weights of hæmoglobin[32, 33] and serum proteins in systems where L′ is constant and also the effects of proteins[34] on the activity coefficients of diffusible ions.[29, 32, 34, 35] Adair[32, 34] also suggested a method for extending the theory to ideal systems with low osmotic pressures, including colloidal solutions in mixed solvents, in which the composition of the solution L′ is expressed in 'corrected concentrations' in gram mols. per litre of the mixed solvent.

$$[S]_c' = [S]_0' \times 100/(100 - V_1 C) \quad (32)$$

$[S]_c'$ = corrected concentration of substance S in L′.

$[S]_0'$ = observed concentration in mols. per litre of solution.

C = grm. colloid per 100 c.c. solution.

V_1 = volume occupied by 1 grm. colloid, including water of hydration.

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[26] Ridley, *Brit. Journ. Exp. Path.*, 1930, **11**, 217.

[27] Davson, Duke-Elder and Benham, *Biochem. Journ.*, 1936, **30**, 773.

[28] Loeb, *Proteins and the Theory of Colloidal Behaviour*, New York, 1922.

[29] Adair and Adair, *Biochem. Journ.*, 1934, **28**, 199.

[30] Adair, *Journ. Amer. Chem. Soc.*, 1929, **51**, 696.

[31] Adair, *Trans. Farad. Soc.*, 1935, **31**, 98.

[32] Adair, *Proc. Roy. Soc.*, 1928, A, **120**, 573.

[33] Adair, *Proc. Camb. Phil. Soc. (Biol.)*, 1924, **1**, 75.

[34] Adair and Robinson, *Biochem. Journ.*, 1930, **24**, 1864.

[35] Adair and Adair, *ibid.*, 1934, **28**, 1230.

The theory of membrane equilibrium may be applied to the process of dialysis, because the rate of removal of a diffusible impurity S_n from a colloidal solution L′, enclosed in a membrane surrounded by pure water is partly determined by the distribution ratio $r_n = [S_n]_c' / [S_n]_c''$

$$-\frac{d}{dt}[S_n]_c' = [S_n]_c' \left(\frac{1}{r_n}\right) k_n \quad .. \quad (33)$$

where t = time, k_n is a coefficient, directly proportional to the area of the membrane, and inversely proportional to the volume of the solution L′ and the thickness of the membrane. k_n is an undetermined function of the shape of the membrane, the rate of stirring and other factors. On the assumption that k_n is a constant, the reciprocal of the distribution ratio, is a measure of the rate of dialysis. Adair's[23] work shows that the effect of salts on the rate of removal of impurities is of importance in studies on systems where the composition of the dialysate is *constant*.

Before we proceed to describe the applications of this theory of membrane equilibrium, it may be pointed out that the presence of a membrane is not absolutely necessary for the existence of the Donnan equilibrium. The theory is applicable to any system which contains some kind of ions, which are not allowed to diffuse to some part of the system. The diffusion of the ions may be hindered either by the formation of aggregates round the ion, or by the absorption of the ion on the surface of the membrane, or some other peculiar property of the ion. For all practical purposes we can assume that the theory of Donnan is applicable even when the ion is able to diffuse, but the rate of diffusion is very small.

OBITUARY.

Sir Nowroji Saklatvala, C.I.E., Kt., K.B.E.

INDIA, the Parsee community and particularly, the House of Tata, incurred last July a grave loss in the death of Sir Nowroji Saklatvala, less than one month after the untimely death of Mr. J. A. D. Naoroji.

Born on September 10, 1875, a nephew of the famous industrialist Mr. J. N. Tata, Nowroji Bapuji Saklatvala was naturally destined for association with Messrs. Tata Sons, Ltd., and this began in 1889 as a cotton-mill apprentice. Rapid promotion was earned by whole-hearted application to work, linked with aptitude, these qualities being recognised outside the firm by his appointment in 1916 to Chairmanship of the Bombay Millowners' Association, which he represented in the Legislative Assembly six years later. Increasing knowledge of the varied interests embraced by the firm, fortified by devoted loyalty thereto, made it appropriate that he should become Chairman at the death of Sir Dorabji Tata in 1932, in which year he was appointed also Chairman of the Tata Iron and Steel Co., Ltd. Thence forward he maintained a detailed interest in the vast Jamshedpur corporation, meriting the gratitude of the employees by addressing himself to an improvement of their conditions and pay through a profit-sharing scheme.

In spite of these heavy responsibilities, Sir Nowroji found time to associate himself with other commercial enterprises including insurance and banking, whilst identifying himself with a recently successful fusion of the various conflicting cement interests. As Chairman of the Sir Dorabji Tata Trust, he guided the disposal of princely charitable funds with vision and wisdom, lately approving the construction of a Cancer Institute. The human side of his character was illustrated by his early work for the Cricket Club of India, and by his uniform encouragement of all social clubs attached to the numerous industrial corporations with which he was connected.

Testimony of employees and business associates alike shows that Sir Nowroji commanded their respect and affection by his integrity and sympathy. Government recognition of his valuable services to Indian industry came with C.I.E. (1923), a Knighthood (1933), and the K.B.E. (1937). Although nominally on holiday at the time of his death he was actually engaged in a business visit to the United States, England and Scandinavia, and was resting at Aix-les-Bains when he died suddenly on July 21, within a few weeks of completing his sixty-third year.

LETTERS TO THE EDITOR.

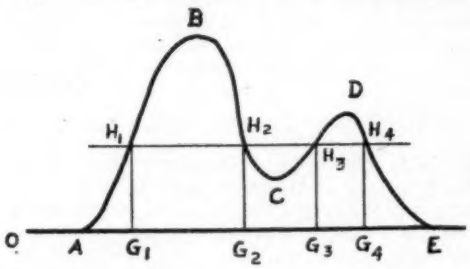
The Fundamental Idea underlying Statistical Tests of Significance.

Suppose an individual has been drawn at random from a known population, but that we are not sure of this. To see whether he could possibly have been drawn from this population we apply a test of significance. This test consists solely in dividing the whole population into two classes A_1 and A_2, such that the number of individuals in A_1 bears to the number in the whole population an arbitrary ratio, P, called the limit for random chance or the limit of significance. If our individual falls in the class A_1, he is not considered significant.

Obviously, this division can be affected in an infinite number of ways; we will have thus an infinite number of tests of significance applicable to the same case. From the point of view of success in the long run each of these tests is as good as any other, provided the same test is used on every relevant occasion. From the practical point of view, however, these tests are not equal and the best test is that based on what may be called the "fundamental idea". Since in a significance test some individuals have to be neglected, the fundamental idea states that the least harm is done by neglecting the least frequent individuals.

We will apply this idea to the following slightly complex case. Suppose the frequency curve is A B C D E, the distinguishing character of the individual being measured along O E.

We now draw H_1 H_4 parallel to OE so that areas $AH_1G_1 + G_2H_2CH_3G_3 + G_4H_4E$ divided by the total area A B C D E is equal to P, our limit for random chance.



Then the class A_1 consists of individuals represented by the intervals AG_1, G_2G_3 and G_4E. H_1G_1, H_2G_2, ··· are ordinates through H_1, H_2, ···.

It is easy to see that only one test of significance follows from this idea. Although the idea is very simple, it does not appear to be well known. In support of this view it may be stated that Clopper and Pearson in their paper[1] have suggested a test of significance in which an area equal to P/2 is cut off at each tail end of a binomial distribution. Again, when Rhodes suggested in the paper[2] two different tests for the same case, Karl Pearson remarked (page 252)[2] "we can test whether two samples are consubstantial in a variety of ways, is it possible to find a better test—by which I mean a more stringent test—than the 'classic method' of examining the distribution of difference?" If the fundamental idea had been used, this difficulty would not have arisen.

More details will be given in a paper to be sent for publication elsewhere.

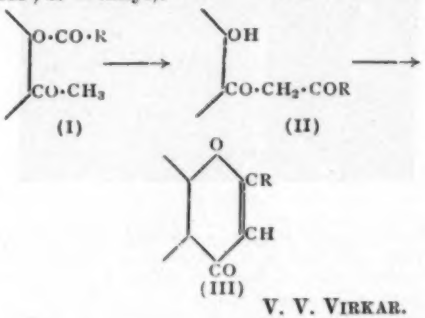
S. R. SAVUR.

Poona, 5,
September 1, 1938.

[1] Clopper, C. J., and Pearson, E. S., *Biom.*, 1934, **26**, 404–13.
[2] Rhodes, E. C., *ibid.*, **16**, 239–48.

Preparation of Flavones from *o*-Aroyloxyacetophenones.

BAKER[1] showed that *o*-aroyloxyacetophenones (I) rearrange with anhydrous potassium carbonate in presence of benzene or toluene into the corresponding *o*-hydroxydibenzoylmethanes (II) from which flavones (III; R = aryl) may readily be obtained by elimination of water. Mahal and Venkataraman[2] and Bhalla, Mahal and Venkataraman[3] used sodamide in dry ether. It has now been found that satisfactory results can be obtained with finely-divided sodium in ether or toluene; sodamide and sodium have the advantage that no water is liberated when the product, the metallic salt of the dibenzoylmethane, is formed. A number of flavones have thus been prepared by the use of sodium, and the method is being applied with advantage in the synthesis of 2-naphthylchromones (III; R = $C_{10}H_7$) of various types. It has been here found that sodium also produces rearrangement of *o*-acyloxyacetophenones thus providing a synthesis of 2-alkylchromones (III; R = alkyl).



V. V. VIRKAR.
T. S. WHEELER.

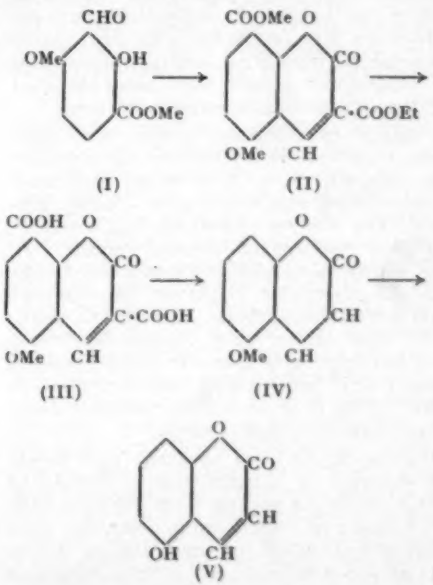
Royal Institute of Science,
Bombay,
September 3, 1938.

[1] *J.C.S.*, 1933, 1381; 1934, 1953.
[2] *Curr. Sci.*, 1933, **2**, 214; *J.C.S.*, 1934, 1767.
[3] *J.C.S.*, 1935, 868.

Synthesis of 5-Hydroxy Coumarin.

5-Hydroxy-4-methyl coumarins which have been difficultly accessible until recently are now readily available through the condensation of methyl-β-resorcylate and resacetophenone with ethyl acetoacetate in presence of anhydrous $AlCl_3$.[1] The method however cannot be obviously applied for the synthesis of the simple 5-hydroxy coumarin which is hitherto unknown. After some unsuccessful attempts this interesting compound has now been synthesised starting with methyl-β-resorcylate.

The 5-hydroxy coumarin was synthesised as follows:—Methyl 2 : 4-dihydroxy-3-formyl benzoate[2] was methylated to methyl 2-hydroxy-3-formyl-4-methoxy benzoate (I) which on condensation with ethyl malonate afforded ethyl 5-methoxy 8-carbmethoxy coumarin-3-carboxylate (II), m.p. 186–88°. This was hydrolysed to 5-methoxy coumarin-3-8-dicarboxylic acid (III, m.p. 281°) which on decarboxylation afforded the 5-methoxy coumarin (IV, m.p. 85–87°). The 5-methoxy coumarin on demethylation yielded the 5-hydroxy coumarin (V, m.p. 221–23°). The 5-methoxy coumarin afforded the 2,6-dimethoxy cinnamic acid (m.p. 151–53°).



[1] *J.C.S.*, 1933, 1381; 1934, 1953.
[2] *Curr. Sci.*, 1933, **2**, 214; *J.C.S.*, 1934, 1767.
[3] *J.C.S.*, 1935, 868.

A detailed account of the above investigation will shortly be published elsewhere.

H. A. SHAH.
R. C. SHAH.

Royal Institute of Science,
Bombay, &
Ismail College, Andheri,
Bombay,
August 6, 1938.

[1] Sethna, Shah and Shah, *J.*, 1938, 228.

[2] Shah and Laiwalla, *Curr. Sci.*, 1936, 197.

Polyploid Plants produced by Colchicine and Acenaphthene.

BY treating germinating seeds of various *Nicotiana* species and hybrids in 0·5 per cent. aqueous solution of colchicine for 20, 40 and 72 hours, deformed seedlings were raised, from which normal and slightly abnormal diploid and polyploid plants of the following species and species hybrids developed: *N. rustica* (in several varieties including the best variety "Khmelevka"), *N. Sanderæ*, *N. glauca*, F_1 hybrids *N. alata-Sanderæ*, F_1 hybrids *N. suaveolens* × *alata*, F_1 hybrids *N. excelsior* × *velutina*, F_1 hybrids between two varieties of *N. suaveolens*, etc. In all these species and hybrids, plants with doubled chromosome numbers were obtained, while in the hybrid *N. alata-Sanderæ*, octaploids were also produced. Sterile hybrids were rendered fertile by chromosome doubling. Tetraploid plants were also obtained in *Phlox* after colchicine treatment.

Treating germinating seeds of Salat (*Lactuca sativa*) with crystals of acenaphthene for six days, I obtained deformed seedlings from which vigorous plants developed. The control plants reached a size of $\frac{2}{3}$ to $\frac{3}{4}$ of the size of treated plants. In other words, acenaphthene has a very high stimulating activity. Among the treated plants with acenaphthene, I found one tetraploid. The latter plant began to flower about ten days later than the diploid treated plants, *i.e.*, it had a much longer vegetation period. This is a profitable character from the agricultural point of view.

Reagent tubes were covered from inside with crystals of acenaphthene. Shoots of various *Nicotiana* species were covered with such tubes and closed from downside with cotton and then left for several days (2–10). Some of the new branches formed from the treated shoots were polyploid. I found in *Nicotiana longiflora*, for example, tetraploid

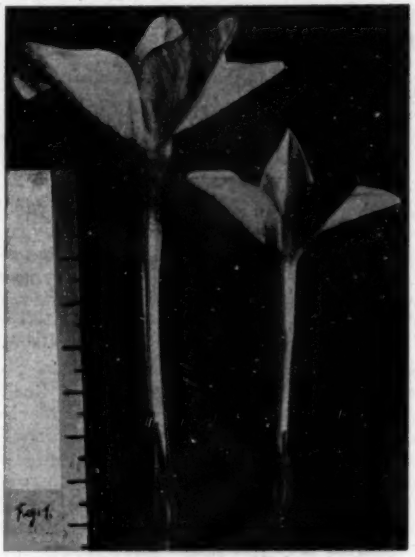


FIG. 1.

Flowers from tetraploid (left) and diploid (right) *N. alata* types.

FIG. 2.

Flowers from left to right: (1) from a tetraploid plant; (2) from a diploid plant of *N. suaveolens* varietal cross; (3) from a tetraploid *N. rustica*; and (4) from a diploid *N. rustica*.

and octaploid shoots. The chromosome numbers in the plants treated with acenaphthene and colchicine were determined in the pollen-mother cells.

Each polyploid plant produced in these experiments had longer vegetation period,

thicker and broader leaves, larger pollen and stomata board cells, larger floral buds, broader corolla tubes, larger trichomes, darker green colour, larger ovules, larger seeds and coarser appearance than the

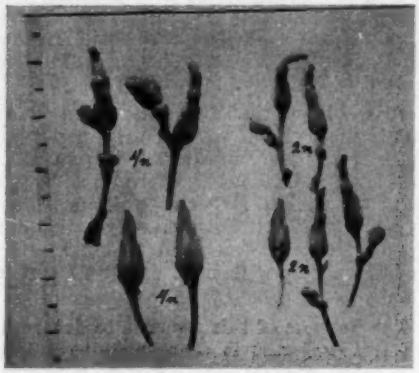


FIG. 3.

Lactuca sativa—left tetraploid, right diploid.

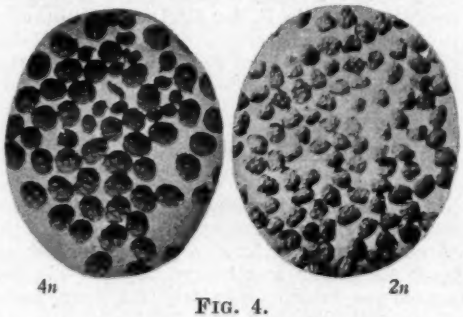


FIG. 4.

Seeds from polyploid *N. longiflora* (left) and from diploid form (right).

diploid ones. Some polyploid plants had much longer flowers, while others had shorter ones as compared with the diploid plants. There were also tetraploid plants in which the flowers were about as long as in the diploid ones.

Discs with equal diameters were cut out of the leaves about 1 cm. below the apex from diploid, tetraploid, and octaploid plants and were weighed. Discs of tetraploid plants were about 30 per cent. heavier than those of the diploids, while those of the octaploids were about 30 per cent. heavier than those of the tetraploids and about 60 per cent. heavier than the discs of the diploids.

The characters.—Weight of the leaves, size of the seeds, length of the vegetation period, size of the flowers, fertility (rendering

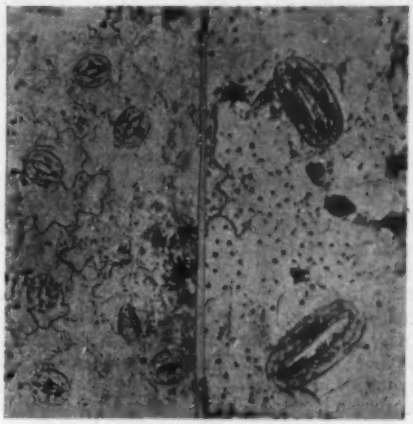


FIG 5.

Stomata board cells of diploid (left) and octaploid *N. alata-Sanderæ* plants.

sterile hybrids fertile and fertile species into partially fertile by chromosome doubling), etc., being affected by chromosome duplication, are of great significance for the plant breeders, especially for the horticulturists.

It is worth while mentioning the following two factors affecting fertility in the autopolyploids: (1) chromosome length and (2) chromosome number. Auto-octoploid *Triticum durum*, for example, obtained by acenaphthene treatment formed multivalent chromosomes during the meiosis of a higher range and was self-sterile, while most of the tobacco species having shorter chromosomes than *T. durum*, formed less multivalents, had more regular meiosis, and their fertility was less affected. Tetraploid *N. rustica*, having 96 chromosomes formed rarely multivalent chromosomes, but it had irregular meiosis, probably because of a too great crowding of the chromosomes, especially during the second meiosis. This seems to bear a causal connection with the non-significant increase of the distance between the nucleus and the cell wall. On the basis of these observations one might conclude that fertility of autotetraploids will be less

affected in plants, having shorter chromosomes and small chromosome numbers.

DONTCHO KOSTOFF.

Institute of Genetics,
Academy of Sciences of USSR,
Moscow,
July 31, 1938.

Minimum Adequate Size of Sample of F_2 required in Experiments on Hybrid Vigour and Inheritance of Quantitative Characters.

IT has been pointed out that the most unsatisfactory feature in hybrid vigour experiments has been the inadequacy of numerical data. Examples of inadequate data are not rare, probably the most outstanding is that of Kadam[1] who based his conclusions on a population of 2, 3 and 4 plants. One of the outstanding reasons for this is the difficulty of obtaining sufficient number of F_1 seeds. Efforts have always been made by workers to compare an F_1 generation directly with the parents and subsequent filial generations. The difficulty of comparing parents with an F_1 generation and not relying on the subsequent generations has compelled them to limit their trials to only small experiments. There are two reasons for not relying upon F_2 and subsequent generations. First is that, in these generations, segregation of genes takes place and therefore, it becomes difficult to observe clearly the manifestation of hybrid vigour; second reason is that because it is almost impossible to use all the F_2 seeds in trials, there is every likelihood of taking a sample of such combinations which may show more or less vigour than the whole population. It is mainly for these reasons that hybrid vigour experiments have not been usually conducted on modern system of field trials, *e.g.*, in randomised blocks and latin squares. Engledow and Pal[2] and Pal *et al*[3] seem to be the only workers who conducted hybrid vigour experiments on wheat in latin squares and randomised blocks so that the data could be subjected to statistical analysis.

Similarly, review of literature shows that for studying the inheritance of quantitative characters, workers have been using, very wide ranged F_2 populations. For instance Nohara[4] based his conclusions on an F_2 population of 24. Whereas Ramiah[5] used as many as 2466. Another worker working on cotton concluded that a certain character was governed by four pairs of factors, the F_2 population on which he based his conclusions was even less than 256 plants which is the least number for getting all the genotypes. Similarly East[6] studied height character in tobacco on an F_2 population of 114 plants, while Howard[7] did the same on 647, 356 and 331 plants in case of different tobacco crosses.

It is evident that there has not been any standardisation of taking F_2 populations for studying the inheritance of quantitative characters. Of course, there is not much harm in taking larger populations but it is quite obvious that there are very few chances to arrive at valid conclusions from such meagre populations as 2, 24 or 114 plants.

The purpose of this paper is to determine:

(1) How far it is admissible to compare F_2 with parents and F_1 in randomised blocks and latin squares in hybrid vigour experiments.

(2) What should be the least adequate size of sample in F_2 for studying the inheritance of quantitative characters? Both these problems do not seem to have hitherto received the attention of the workers. These will be dealt with separately under two different headings, namely, hybrid vigour and inheritance of quantitative characters.

I. Hybrid Vigour.—According to Mendelian laws of inheritance if the difference between two characters is governed by three pairs of factors, a population of at least sixty-four is required to have all the genotypes in F_2. Similarly for four pairs of factors 256, for five 1024 and for six 4096. To compare F_2 against parents and F_1 in randomised blocks and latin squares it will be necessary to grow in each block a population of 4096 in case of six pairs of factors or at least such a representative sample average of which may not differ from that of 4096 plants. When looking into this aspect of the problem the following questions are apt to arise:—

(1) Whether the total F_2 population raised from F_1 is the same or is at least representative of the expected F_2 population.

(2) If the total F_2 population is the same as the expected F_2 or is representative of that, what should be the minimum adequate size of the sample which may be obtained

from that very population so that it may be represented.

(3) Whether the size of the sample determined for any character will be adequate in case of all the characters to be studied in that cross.

(4) Whether the size of the sample and of population determined for any one character will be adequate for that very character in whatever cross and wherever it may be studied.

To solve the above mentioned questions, if different sized samples are obtained from a population and such samples are secured, the means of which do not differ from each other statistically and also lie within the limits of the general mean ± twice its standard error, it will be concluded that such samples will be representative of the whole population. If from a certain population such adequate samples cannot be obtained, that population may not necessarily be sufficient and it may not represent the expected or actual F_2 population. Thus the representativeness or otherwise of a population or a sample can easily be determined for different characters.

It is obvious that if F_2 population raised from an F_1 generation is not the same or representative of the expected F_2 population, it is erroneous to grow the whole of the population as in lots or small inadequate samples. In both the cases the validity of the conclusions will be affected. If the population for certain character is proved to be quite adequate appropriate minimum size of a sample shall have to be determined for that character as explained above. Both adequate populations as well as samples shall have to be determined for all the characters in case of different crosses. Should 200 be the adequate minimum size of sample for height in a paddy cross, a population of at least 1,200 will be required for six replicates in randomised blocks and 800 for a latin square of four columns and four rows. Growing of less than 200 plants in any block, row or column will not be permissible.

From published data in case of about half a dozen crops, both size of population as well as of sample were determined. It was seen that in most cases the adequate size of sample ranged between 200 and 300. But, however, there were cases where even a sample of 500 did not prove to be representative, and in some cases the population was so small that a representative sample could not be determined, *e.g.*, from East (*loc. cit.*) data of 114 plants, Howard (*loc. cit.*) data of 100 plants and Shaw and Bose[8] data of 300 spikelets. However, it is a matter of detail and will take time to standardise the size of population as well as of sample for different crosses.

In view of what has been said above it is concluded that comparison of F_2 with parents and F_1 in randomised blocks or latin squares will only be admissible if in each block, row or column such a sample is grown as may either be the same as the expected F_2 population or a representative of it.

II. *Inheritance of Quantitative Characters.*—Importance of study of inheritance of quantitative characters hardly needs any emphasis. Much work has been done in this line in case of all the farm crops. The workers on this subject, as mentioned before, have been using very wide ranged F_2 populations, *e.g.*, 24–2,466 or more. There can hardly be any justification for basing conclusions, such as, that a certain difference between two characters is governed by four pairs of factors, on a meagre population of twenty-four plants. A population which is neither the same as the expected F_2 nor is representative of that, cannot be relied upon for such a study.

As already explained under hybrid vigour there seems to be a necessity for determining the adequate size of a sample for each and every character for all the crosses. In such a study as inheritance of quantitative characters there is no harm in taking as large a sample as possible, but in no case less than the adequate size of sample determined for a certain character is permissible. Validity of the conclusion based on a population which may not be reperesentative of the expected F_2 population, is subject to a great deal of criticism.

CH. NEK ALAM.

Department of Agriculture,
Gurdaspur,
June 22, 1938.

[1] Kadam, Patil and Patankar, *Ind. J. Agric. Sci.*, 1937, 7, 118.
[2] Engledow and Pal, *J. Agric. Sci.*, 1934, 24, 390.
[3] Pal and Alam, *J. Ind. Sci. of Acad.*, 1938, 7, 3, 109–24.
[4] Nohara, *J. Coll. Agri. Tokyo*, 1933, 12.
[5] Ramiah and Parthasarathi, *Ind. J. Agric. Sci.*, 1933, 3, 808.
[6] East, *J. Gen.*, 1916, 1, 164.
[7] Howard, *Mem. Dept. Agric. Ind.* (*Bot. Ser.*), 1913, 6, 52, 3, 89.
[8] Shaw and Bose, *ibid.*, 1933, 3, 771–807.

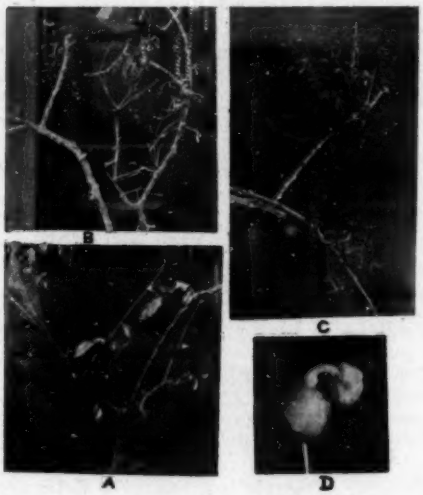
A Case of Triple Parasitism ? *Loranthus* vs. *Viscum* vs. *Viscum*.

SPECIES of *Loranthus* and *Viscum* form the most common semi-parasites on many of the deciduous forest trees in the neighbourhood of Bangalore. The membres of Loranthaceæ come next to those of Santalaceæ, so far as the number of hosts they affect. They have also some common hosts (1923). It is very rarely that one comes across a *Loranthus* growing parasitic on another *Loranthus* or *Viscum* and *vice versa*. Brown (1918) reports a case of double parasitism of *Phoradendron californicus* on *Phoradendron flavescens* near Tucson. Morris (1922) records a case of *Loranthus exocarpic* growing on *Loranthus pendulus* and *Loranthus quandong*.

An interesting case of double parasitism was noticed in which *Loranthus longiflorus* Desv., acting both as a partial parasite and a host was found on *Shorea talura* Roxb. The host plant is grown extensively for the cultivation of lac. *Loranthus longiflorus* forms a serious pest on it, in some cases bringing down its vitality considerably. Practically every plant in the locality has been attacked by one or many parasites, which appear to be quite hardy. *Loranthus longiflorus* Desv. has been found to be attacked by a *Viscum* (Fig. A and B) *Viscum ramosissimus* Wall, which is quite unlike the common species of the locality, *viz.*, *Viscum orientale* (Fig. C). Thus the host-parasite relationship in this case was not between two Loranthi but between a *Loranthus* and a *Viscum* which is rather rare and appears to be the only instance on record. The water relations of these associations must be very complex and interesting as suggested by Harris and others (1930).

A further interesting stage in this relationship or association has been observed, where not only the *Loranthus longiflorus* Desv. acts both as a semi-parasite and a host but also the Viscum—*Viscum ramosissimus* Wall.

In its turn *Viscum ramosissimus* grows on Loranthus parasitically and at the same time it allows a number of its own seeds or those of other viscum plants to germinate on its body so that some of them at least might establish themselves as full-grown parasites. A curious example of this kind is the germination and growth of a Viscum seed on a just ripening fruit, evidently that of *Viscum ramosissimus* (Fig. D). The seed must have settled on this fruit when it was very young and has germinated and produced the disk by the time the fruit has matured.



A.—*Viscum ramosissimus* on *Loranthus longiflorus*.

B.—Several plants of *Viscum* growing on a single branch of *Loranthus*.

C.—Two clumps of *Viscum* to show the details of their habit.

D.—*Viscum ramosissimus* seed germinating and growing on a fruit of *Viscum ramosissimus*. × 5.
(Figs. A, B and C have been reduced while photographing.)

Can these instances be called Triple Parasitism ? Anyhow, the host-parasite relationship of these associations becomes more complex.

L. NARAYANA RAO.

Central College,
Bangalore,
August 15, 1938.

1. Brown, J. G., *Bot. Gaz.*, 1918, **65**, 2, 193.

2. Harris, J. A., Harrisson, G. J., and Pascoe, T. A., *Ecology*, 1930, **11**, 687–702.

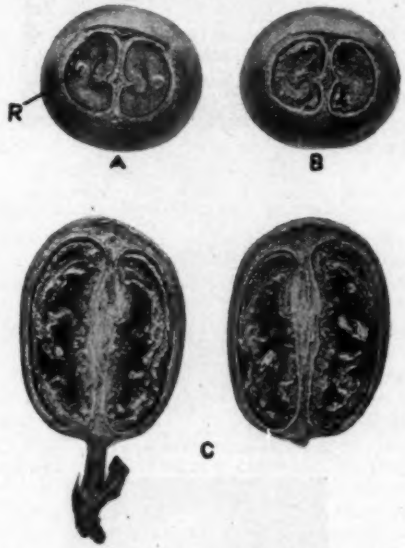
3. Jivanna Rao, P. S., *Indian Forester*, 1923, **49**, 416–28.

4. Morris, A., *Aust. For. Jour.*, 1922, **5**, 325.

Coffee Black Bean.

BLACK BEAN in Coffee (*Coffea arabica* Linn.) has been known for a long time. Reports and samples have been received from different coffee estates in the Mysore State during the years 1921 to 1928, but the losses have scarcely been heavy. Thomas[1] has mentioned black been in coffee. Mayne[2] has devoted a good deal of his time to this obscure disease during the years 1930–31 to 1937–38. He is of opinion that it is due to an abnormality of the inner silver-skin layer or nucellus.

Last year a bad case was reported from an estate near Kalasa in Kadur District. Investigations on the spot led to the interesting observation that black bean is associated with the absence of the embryo (see Fig. B).



A.—A healthy fruit of *Coffea arabica* Linn. in cross-section. R, is the radicle of the embryo.

B.—A black bean fruit of *C. arabica* in cross-section at same level as *A*. Note absence of embryo and disintegration of the endosperm.

C.—Another black bean fruit of *C. arabica* in longitudinal section.

Black bean fruits develop on the plant just like the other fruits, and may sometimes be detected by feeling them. They appear not as full as healthy fruits and feel very much like wilted fruits due to loss of turgor. The affected fruits do not drop down but remain on the plant till the other fruits mature. When an affected fruit is cut the bean is found to be black inside. This condition may be present in only one bean or in both beans of such a fruit. Even the single bean of the peaberry may be black. The endosperm is collapsed. Sometimes the affected beans do not turn black, but are only shrivelled. The blackening is probably only a change that takes place in the endosperm due to the non-development of the embryo. The black bean is very light, the parchment being intact, and comes up in the pulping vat as floaters or skimmings.

The possibility is that pollination or fertilization has not taken place. Sterility in coffee has been known to occur.[3] Due to the absence of pollen or due to its incompatibility, the fruit may develop parthenogenetically. A great deal of hybridization work has been going on in coffee during recent years, and a large number of varieties and species have been introduced for this purpose. Side by side natural hybridization has perhaps taken place. Hybridization has been known to lead to parthenogenesis,[4] and it is possible that many of the coffee plants, which might be only natural hybrids, develop some of their fruits parthenogenetically. Feng[5] has found in the seeds of Asiatic-American hybrids of cotton a very small embryo or none at all, even though they possessed well-developed seed-coats. "The ovules of the sterile F^1 hybrids were shrunken, dry and black; moreover no fibres developed on the seed-coats even though the bolls had been retained on the plant as long as three months. The ovules apparently do not develop at all." This is somewhat similar to what takes place in black bean of coffee.

Zimmermann[6] says that hybrid beans have a dissimilar colour to that of their parents and that a large number of them are barren. Of great interest in this connection is his description of the variety of coffee known as "Einsamiger kaffee" (*Coffea arabica* var. *monosperma*) which flowers profusely, but ripens only a few fruits, a majority of these being barren. In isolated cases there is one seed which is not germinable. In Java these trees are often called "mannetjes koffie". Hybrids rarely give satisfactory yields. Notable exceptions to this are the Kawisari

hybrids of Cramer, but even here a certain number of fruits are barren.

S. V. VENKATARAYAN.

Department of Agriculture
in Mysore, Bangalore,
August 26, 1938.

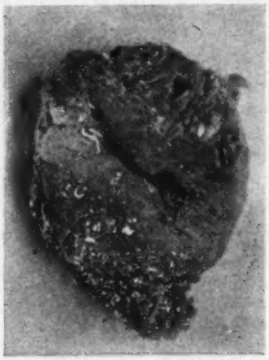
[1] Thomas, K. M., *Planter's Chron.*, 1924, **19**, 697–704.
[2] Mayne, W. W., "Annual Report of the Coffee Scientific Officer, U.P.A.S.I., 1930–31 to 1937–38."
[3] von Faber, F. C., *Annales du Jardin Botanique de Buitenzorg*, 1912, **25**, 59–160.
[4] Woodworth, R. H., *Bot. Gaz.*, 1929, **88**, 391.
[5] Feng, C. F., *ibid.*, 1935, **96**, 485–504.
[6] Zimmermann, A. Kaffee, *Wohltmann-Bücher Monographien zur Landwirtschaft warmer Länder*, 1928, 3 Aufl., Bd. **4**.

A Case of Commensalism between a Lamellibranch and a Monascidian.

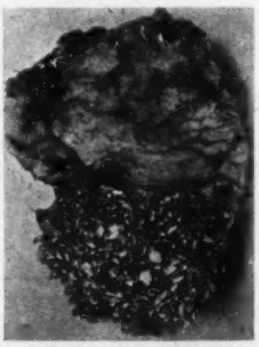
IN *Current Science*, March 1937,[1] I reported a typical case of commensalism between a Gastropod (*Turbinella pyrum*) and a Monascidian (*Herdmania pallida*) of the Indian seas, and said, "Both animals are typically Indian and it would be worthwhile to investigate the phenomenon in other Indian animals." The present communication deals with another case of commensalism between a lamellibranch and the above-mentioned monascidian. The forms were collected by me from the sea at Tuticorin, and their presence was mentioned in my monograph[2] on *Herdmania*, in January 1936. The lamellibranch was later sent for identification to Dr. Marie V. Lebour of Plymouth, who, placing it in the genus *Musculus* (Filibranchia, fam. Mytilidæ) remarked that it resembles *M. cœnobita* in its characters. The author could not get the relevant literature in India and is not quite certain if it is *M. cœnobita* or a new species of *Musculus* altogether. Whatever the species, to my knowledge this is the first time that *Musculus* has been recorded from an Indian ascidian.

My best thanks are due to Dr. Marie V. Lebour of Plymouth who kindly identified the forms for me and also sent me some references to literature on the subj ct. I am indebted to Prof. K. N. Bahl of Lucknow for giving me the necessary facilities for carrying on this work as well as for reading this manuscript.

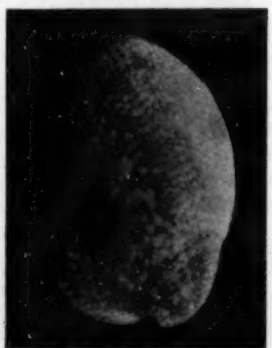
The present species of *Musculus* inhabits the test of the monascidian *Herdmania pallida* in large numbers. In my morphological work on *Herdmania* I dissected over 200 specimens of the monascidian, and almost 80 per cent. of the animals had one or more lamellibranchs imbedded in their test. One specimen of *Herdmania* had as many as



1. *Herdmania pallida* seen from the right side, showing five *Musculus* shells imbedded in the test (× ⅔).



2. Left side of *Herdmania pallida* showing one large and one small *Musculus* (× ⅔).



3. Outer surface of the shell of *Musculus* showing its speckled and striated nature (× 2½).

4. Inner surface of the same shell with the byssus attached (× 2½).

40 lamellibranchs, both large and small, in its test. *Musculus* occurs almost throughout the test, but is found more often at the free rather than at the fixed end of the animal; and is arranged in larger numbers around the branchial than the atrial siphon. Each animal is found in a cleft in the test through which it communicates with the outer world to feed and to respire.

The shell is white-speckled brownish-yellow in colour and rhomboidal in shape and bi-symmetrical. The samllest forms measured 4 mm. × 6 mm. while the largest forms were 10 mm. × 16 mm. It is sculptured by two rows of striæ (one on each side) which radiate from the beak leaving the middle part smooth. The ridges of these striæ are brownish while the depressions are white. The hinge-plate is finely notched. The umbones are incurved forming a depression at the joint. The edges of both halves of the shell are crenulated, the ends of the striæ of one fitting into the depressions of the other.

The mantle is leaf-like, rather thick and opaque on the dorsal half of the body, the anterior and posterior-most parts forming the siphons. The incurrent tube is wide while the excurrent tube is rather conical. The anteior adductor muscle is fairly high.

There is a large hairy byssus, consisting of a large number of byssus threads at the mid-ventral end of the animal (foot). The hairs of the byssus are very sticky.

The gills are rather thin and the lamellæ loosely placed. The labial palps are four in number, one pair on each side of the body. In each pair one palp is placed before the other and the lower ends of the palps are curved inwards.

The foot is strap-shaped and is quite tough.

Remarks.—*Musculus* has so far been recorded only from Temperate and Arctic Seas. The species of this genus exhibit a propensity for concealment, frequently spinning a nest of sand and shell fragments burrowing into soft substances (*e.g.*, ascidian test) or secreting themselves in the burrows of other shells. Of the three species recorded from ascidians, only *M. cœnobita* has been recorded from the Suez Canal and the Red Sea. The other forms are the British *M. marmorata*, which lives imbedded in the test and mantle (integument) of *Ascidia mentula*[3] or *Ciona*, *Ascidiella*, *Phallusia*, etc.; and *M. impacta* in *Boltenia* or other Tunicata.[4]

The association between *Musculus* and *Herdmania* appears to be constant, as more than 80 per cent. of the ascidians bear the lamellibranch in their test. It is apparent that *Musculus* gains protection from the outside world by remaining almost completely imbedded in the test substance; and also gets enough food-material as there is a constant food-current maintained by the ascidian. The fact that a larger number of forms are arranged around the branchial than the atrial siphon indicates that food brought with the current of water which enters the branchial siphon of the ascidian is also used by the lamellibranch. *Herdmania*, on the other hand, does not appear to gain any advantage by having the mollusc as a commensal. The case is nevertheless one of true commensalism between two species belonging to widely separated groups of animals.

S. M. Das.

Department of Zoology,
Lucknow University,
August 8, 1938.

[1] Das, S. M., *Curr. Sci.*, 1937, **5**, No. 9.
[2] Das, S. M., *Ind. Zool. Mem.*, 1936, No. 5.
[3] Jeffrys, I., *J. Br. Conchology*, **2**.
[4] Pelseneer, P., *Essai d'ethologie zoologique des mollusques*, 1935.

Codling Moth in Afghanistan.

The Codling moth (*Cydia pomonella* Linn.) is a serious pest of apples, pears and quinces in Europe, United States of America, Canada, South Africa, Australia and New Zealand. Until recently there was only a doubtful record of this insect from Dras Ladakh (Kashmir) in the Indian Empire (Fletcher, 1919) but it has now been definitely recorded from Baluchistan and the North-West Frontier Province (Pruthi, 1935 and 1938).

So far the insect has not been recorded from adjoining countries like Afghanistan and Iran.

In 1934 a few baskets of apples freshly imported from Kandhar (Afghanistan) were examined at Chaman and quite a good number of apples showed typical Codling moth injuries although no larva was found in them. In 1935 I went to Afghanistan and visited the important fruit-growing centres at Kandhar (about 4,000 ft.), Ghazni (about 8,000 ft.) and Kabul (about 5,500 ft.). On examining apples in the orchards it was discovered that most of them are attacked by Codling moth. A bagful of such infested apples was brought and caterpillars were reared from them at the Fruit Experiment Station, Quetta. The moths emerged out of them have been identified as Codling moth (*Cydia pomonella* Linn.—Family *Eucosmidæ*) by the Imperial Institute of Entomology, London. Again a good number of over-wintering larvæ were got in March, 1938, from Kandhar through the courtesy of a friend there and were reared at Quetta. The adults emerged out were Codling moths. Codling moth is, therefore, present in Afghanistan.

NAZEER AHMED JANJUA.

Department of Agriculture,
Baluchistan, Quetta,
June 27, 1938.

Fletcher, T. B., *Rept. Proc. 3rd Ent. Mt.*, Pusa, 1919, 148.

Pruthi, H. S., *Agric. & Live-stock in India*, 1935, **5**, 522–23.

Pruthi, H. S., *ibid.*, 1938, **8**, 42–43.

Gynura crepidioides Benth.

IN the July number of *Current Science* Dr. van Steenis of Buitenzorg has commented upon the rapid spread of *Gynura crepidioides* Benth., an African compositæ, in south-east Asia.

This plant first came to my notice in the plains of Assam, at Charduar, in 1931. Even then it was a common weed all along the foot-hills. Since that time I have watched its spread into all the districts of Assam, until now it is one of the commonest weeds in the plains.

I did not observe it at Jamiri (4000') in the Aka Hills in 1931, but it had made its appearance there by 1934. This is remarkable because the hills between Jamiri and the plains are covered with dense evergreen tree forest.

In 1935, I noticed this species in the Naga Hills and the Deputy Commissioner, Dr. J. H. Hutton, told me that within a few years it had become common enough to excite comment. During the course of a transfrontier tour in the same year, this plant was also seen east of the Nanteilek river at Nimi (3000') and not far from the Burmese frontier.

It is one of the commonest weeds in Sadiya where, from the rapidity with which it grows, it has become a pest in regeneration areas of *Terminalia myriocarpa*.

The rapidity with which this exotic has spread all over Assam exceeds the performance of that other compositaceous plant, *Eupatorium odoratum* Linn.

In Assam, where man is in his element as a destroyer of climax vegetation, the spread of exotics is greatly facilitated by the infinite variety of bare areas exposed. The weed *Eupatorium odoratum* Linn. which was common in Sylhet and Cachar in Hooker's day, found its way to Upper Assam barred for many years by the evergreen forest of the North Cachar Hills. The opening of the hill section of the A. B. Railway and the destruction of climax forest for cultivation in its neighbourhood, provided a convenient path by which it invaded the Assam Valley. Within the past twenty years it has established itself firmly in the plains and hills.

It is very significant that *Gynura crepidioides* Benth. is mentioned neither by Biswas (1934)[1] in his excellent account of the distribution of some foreign weeds in India and Burma, nor by Calder and his collaborators (1926)[2] in their list of species of phanerogams not included in the *Flora of British India*. One can conclude from this that *Gynura crepidioides* was absent from the flora in 1926.

For a plant to have spread all over the Province of Assam, situated as it is, hundreds of miles from any seaport, shows powers of migration and ecesis which are very remarkable. One factor which has undoubtedly a very important bearing upon its distribution is its capacity for producing flowers and fruits all the year round, as well as its tolerance towards very diverse edaphic conditions.

N. L. BOR.

Forest Research Institute,
Dehra Dun,
September 5, 1938.

[1] Biswas, K., *Curr. Sci.*, 1934, **2**, 422.

[2] Calder, G. C., Narayanaswami, V., and Ramaswami, M. S., *Rec. Bot. Sur. India*, 1926, **11**, No. 1.

***Eupelmus tachardiae* and its Five Hosts.**

To my last criticism[1] still doubting whether *Eupelmus tachardiæ* has as many as five different hosts distributed among three families of insects, Negi[2] and Gupta have replied.

The assertions of Glover and Negi[3] were weakest with regard to *Eupelmus tachardiæ* acting as an internal parasite of lac insects; the best way to prove such a theory was to offer direct evidence, by reproducing a photograph where the lac insect, and not the lac cell, contains the pupa of this chalcid.

In order to facilitate what might have been done for *Eupelmus tachardiæ*, I[4] reproduced, in Fig. 6, a picture of a lac insect with its skin intact, nevertheless, containing the larvæ of *Erencyrtus dewitzii*, a genuine endo-parasite of lac. Imms[5] and Chatterjee, in their Fig. 34, have likewise shown a chalcid larva visible through the transparent skin of the lac insect. A similar photograph showing the pupa and not the larva of *Eupelmus tachardiæ*, would have been the proper evidence to offer.

I may perhaps now add, that the presence of such objects can be easily revealed by dissolving a colony of lac insects, suspected to be attacked by the endoparasite with alcohol; the healthy lac insects appear dark and carmine coloured, while those containing the pupæ or larvæ of chalcids possess a transparent skin, through which the contents are conspicuously displayed. When the chalcid, as imago, is dark, *e.g.*, the male of *Coccophagus tschirchii*, its mature pupa is also black and a lac insect, harbouring such a specimen of a parasite, is one of the easiest objects to discover. Now the adult of *Eupelmus tachardiæ* is even darker than the male *Coccophagus tschirchii*, besides being the largest chalcid met with lac. A lac insect, had it contained such a large and dark pupa, could not have escaped my observation, for I have used this technique for a number of years. On the contrary, Negi and Gupta never mention, in any of their writings, their ever having used such an exhaustive and systematic method of study.

All the proof they[6] have tried to bring forward is shown in their Fig. 3, where they confess, the pupa of *Eupelmus tachardiæ* is not seen within the skin of the lac insect, but merely within a lac cell. This, naturally, can be interpreted to show the pupa in question was directly associated with the larva of *Eublemma amabilis* whose remains are not seen, since the photograph unfortunately is out of focus and all details are not visible; even the complete outline of the lac cell is not reproduced.

The second and indirect evidence to show that an insect is endoparasitic is by demonstrating a large number of exist holes all indicating uniformity. That such is possible was clear by an example of *Lakshadia communis* colony attacked by *Erencyrtus dewitzii*, a chalcid which had attacked practically every cell seen in Fig. 5 of my[4] last letter. I had emphasised, that in bringing in such indirect evidence, the number of holes made by the chalcid should be large and that the colony of lac insects should not be attacked by more than one species of chalcid, even putting the words, *total and pure*, to qualify such apertures, in thick print. I would ask Negi and Gupta to bring forward similar picture of lac insects attacked in large numbers by *Eupelmus tachardiæ*.

They[2] have, however, offered Fig. 4, a single lac cell which appears, on critical observation, strange and curious in the light of their own explanation. I reproduce their Fig. 4 with my letter-markings, the exit hole, A B C D, is more rectangular than circular, which may be granted as possible, but from D to E there appears a regular cleft which makes the picture

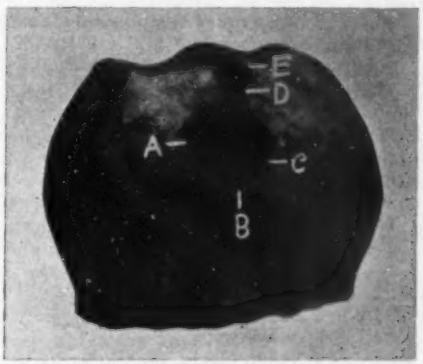


FIG. 4 of Negi and Glover explained as, "Microphotograph of female pupa of *E. tachardiæ* in a nearly fully developed female lac cell showing a hole by biting which female *E. tachardiæ* emerged. × 18". Please note the absence of any pupa in the illustration. The letter-markings are mine; the exit hole, A B C D, is rectangular, while, from D to E, there appears a regular cleft.

invalid. With regard to the exit hole they say "the greatest width of the hole made by *E. tachardiæ* shown in Fig. 4 is 0·83 mm. and the width of the head of *E. tachardiæ* is also 0·83 mm." When the head of the insect and its exit hole is of the same size, correct to 1/100 mm. I may maintain, without fear of any contradiction, no chalcid would be able to emerge on account of the great friction caused by such a narrow aperture. I find these exit holes are always larger than the size of the heads possessed by their respective chalcids.

They explain their Fig. 4, as a "Microphotograph of female pupa of *E. tachardiæ* in a nearly fully developed female lac cell showing a hole, by biting which female *E. tachardiæ* emerged. × 18". The language is so confusing, that I fail to know what they mean by a female pupa of *E. tachardiæ*. I see no pupa of any kind in their Fig. 4, nor have they lettered it.

In my last letter I had explained, a definite relationship exists between the size of the pupa of an endoparasite and that of the body of its host, particularly implying, the pupa of *Eupelmus tachardiæ* is too large for it to act as an endoparasite of lac. Negi and Gupta now admit the larval stages of lac insect are free from the attack of this chalcid. I had previously stated and might perhaps repeat, all the chalcids I have studied as directly attacking lac, have two life cycles, *one stage passing in the larval and the other in the adult stage.* Nor do I know of any other chalcid which attacks only the adult scale insect and not its larva.

The body of the lac insect is really so small that merely this consideration excludes the probability of *Eupelmus tachardiæ* acting as an internal parasite. Negi and Gupta have apparently seen this view-point while they indirectly admit that a pupa of this chalcid is so large that it cannot lie straight within the body of the lac insect; their words are, "the female lac insect measures about 2·8 mm. and the female *Eupelmus tachardiæ* larva and pupa when found in the lac females lie in a curved position (not straight as is usually the case with all chalcids) as will be seen from Fig. 3"—the text in brackets is mine. Their Fig. 3 has been already shown as being out of focus and therefore inadmissible as proving the point they claim. It would have been better to show such a pupa, with a curved body, in clear profile, *i.e.*, sideways, contrasting with the normal one, already illustrated by me.[8] They have illustrated a pupa seen ventrally,[9] which exhibits no abnormality and is, in fact, a *confirmation* of my previous picture[10] of the same object with this disadvantage, that Negi's and Gupta's photograph shows the pupa with a long white appendage, not explained either along with the illustration or in the text. I do not admit, it is ever possible for an endoparasitic pupa to mature in such a small host as to acquire an abnormal and curved body from want of space—a definite reference to a similar finding of another worker, if at all any, would shorten the controversy! In such a case the pupa would be small with the body normal and not curved. Negi[11] and Gupta state, "it was incorrect of Mahdihassan to suggest our having ever said that *E. tachardiæ* was found parasitic on the second instar lac insect". I do not believe I ever meant such a suggestion originating from them and I naturally demand a quotation from my writing which has led them make such an imputation.

The first illustration of a larval *Eupelmus tachardiæ* was published by me,[7] where Fig. 1, a pen and ink drawing, clearly shows the presence of long hairs. Negi[3] and Glover later issued another picture of it Fig. 1(*d*), which they claim as excellent but which, I believe, does not represent an improvement in showing the long hairs, which Negi and Gupta now so much wish to emphasise. They are second to give out an illustration of the larva of this chalcid and are not justified in advancing their claims of having discovered this character saying, "we are surprised that Mahdihassan who claims to know the various chalcid and braconids found in lac has not been able to notice this conspicuous difference." If my[7] previous figure of the larva had shown something less than theirs,[3] their remark would be justifiable and I leave it to the reader to compare my former picture[7] of the larva with their[3] later duplication of it and see for himself which brings out the long hairs of the larva into greater prominence. Likewise their[2] recent Fig. 1*b*, of the pupa seen ventrally, shows nothing new nor better compared with mine, Fig. 2, previously[4] offered.

Negi and Gupta, who like to live in the blissful ignorance of what has been published on lac by others, naturally take no cognizance of the fact that I have[12] already

illustrated the pupal and pre-pupal stages of the male lac insect and as such their kind suggestion that, I should consult Imm's *Text-book of Entomology* for a definition of pre-pupa, is superfluous. What was needed and what I still request of them is a definite reference to the finding of a worker on chalcids who has found these two moults, the pupal and pre-pupal, in any of the endoparasites of a scale insect.

Originally, when their Fig. 1(*c*) appeared, no details were given and it is later on that they add that their illustration represents a male and that it offers an abnormal view since the specimen was boiled in hot water, a technique as unique as it is primitive. They blame me for not knowing what they fail to communicate. The abdomen terminates, in a distinct curve towards the dorsal surface, which even in its abnormal appearance, would not characterise a male insect. At any rate, it is pertinent to ask for a pupa of female insect similarly treated with hot water and carefully photographed, for, until this is done, they have demonstrated only a mysterious object.

In their last reply, Negi[2] and Gupta bring fresh pictures, one poorer than the other, and all not quite so relevant to the main thesis. Fig. 2(*b*) shows a larva which may pass for that of an ant; the long hairs, which Negi and Gupta undertake to point out with an air of originality, are sadly missing in this picture. Fig. 2 (*a*) is so much out of focus that it may pass for the larva of a lepidopterous insect which is moreover only partly seen; while Fig. 2 (*c*) is even worse than their Fig. 2 (*b*).

In my last letter I had confessed it has not been possible for me to identify any of the internal parasites of lac by means of characteristic exit holes made by the chalcids. As though this has been meanwhile achieved by Negi and Gupta they state the hole made by *Erencyrtus dewitzii* measures 0·55 mm. while that made by *Parechthrodrynius clavicornis* measures 0·64 mm. I assert these figures are too good to be true as characters of identification and merely serve as space-filling data. They never mention the *range of variation* and the *average* size of these holes which are important factors in presenting such figures. Their respective illustrations of the exhit holes made by the above two chalcids have thus no significance. Further the exhit holes made by *Erencyrtus dewitzii* have been illustrated by me[4] previously and I find nothing new or exciting in the photograph offered by Negi and Gupta.

In their Fig. 5 is seen an adult female *Eupelmus tachardiæ* and its male in Fig. 8, both macrophotographs. Both illustrations are wanting in even such details, as distinguish the genus *Eupelmus* from *Anastatus*, so that it is impossible for any specialist on chalcids to see the specific characters of this insect. Von Gernet, long ago, illustrated both the male and the female *Eupelmus tachardiæ* and I maintain his figures enable better identification than those of Negi and Gupta. What bearing this inefficient duplication of pictures has on the points they have been all along asked to clarify, I do not see.

Negi and Gupta write, "Again Mahdihassan has indirectly tried to put into our mouth that the lac insect parasitised by *Eupelmus tachardiæ* survives and that three pupæ of *E. tachardiæ* were found in a dead lac insect, although we have never said so." I at once admit they have not said so and in exchange I wish they would accept the responsibility for such a misinterpretation of my writing. They have apparently set their hearts on creating myths and I have set mine on destroying them.

I have to thank my friend, Dr. Winkler, now of Zeiss-Werk, Jena, for kindly giving me the copy of *Current Science* where Negi's and Gupta's last letter appears.

S. MAHDIHASSAN.

The American Express Company,
Berlin,
April 14, 1938.

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1 *Curr. Sci.*, 1937, **6**, 59.
2 *Ibid.*, 1938, **6**, 387.
3 *Ibid.*, 1935, **4**, 37.
4 *Ibid.*, 1937, **6**, 61.
5 Imms and Chatterjee, *Ind. For. Mem.*, 1925, **3**, Pt. 1, Fig. 34.
6 *Curr. Sci.*, 1938, **6**, 390.
7 *Ibid.*, 1935, **3**, 564, quotation from Prof. Lefroy; also *ibid.*, 1936, **5**, 292.
8 *Ibid.*, 1937, **6**, 59, Fig. 1.
9 *Ibid.*, 1938, **6**, 388, Fig. 1 (*b*).
10 *Ibid.*, 1937, **6**, 60, Fig. 2.
11 *Ibid.*, 1938, **5**, 389.
12 *Bin. Ent. Res.*, 1929, p. 241.
13 *Casopis Csl. Spol. Entom.*, 1931, cas. 1–2, **28**—II.

REVIEWS.

The Newer Alchemy. By Lord Rutherford. (The Cambridge University Press, London), 1937. Pp. 67. Price 3*s*. 6*d*.

This book of 67 pages contains in an expanded form the subject-matter of the Henry Sidgwick Memorial Lecture delivered at Newham College in November 1936. It contains a brief but very clear account of modern work on the transmutation of the elements. The following section headings taken from the book will give an idea of the sequence of thought followed in it: Radioactive Transformations—Elementary Particles—Detection of Fast Particles—the Expansion Method—Electric Method—Transformation of Elements by α-Particles—Discovery of the Neutron—Production of Radioactive Bodies—Artificial Methods of Transformation—Transformation by γ-Rays—General Conclusions. The book is illustrated by a fine selection of photographic illustrations amongst which the following may be noted :—α-particle tracks—β-particle tracks—records of particles by the electric method—scattering of α-particles—transmutation of nitrogen by α-particles—recoil tracks produced by neutrons—tracks in photographic emulsions showing transmutations of boron—high voltage installation at Cambridge—deuteron beam produced by cyclotron—α-particles from bombarded lithium—disintegration of boron—transmutation of deuterium by deuterons.

As might naturally be expected in a work by Lord Rutherford, the subject is handled in a masterly fashion. The book makes fascinating reading and should be in the hands of every one who wishes to read an authoritative account of the recent fundamental advances in nuclear physics and chemistry. The reviewer has read and re-read the book with the keenest pleasure.

C. V. RAMAN.

Science and Music. By Sir James Jeans. (The Cambridge University Press, London), 1937. Pp. 258. Price 8*s*. 6*d*. net.

In the present book, Sir James Jeans has endeavoured to describe the main outlines of such parts of science, both old and new as are specially related to the questions and problems of music, assuming no previous knowledge either of science or of mathematics on the part of the reader. His aim has been to convey precise information in a simple non-technical way in the hope that the subject-matter selected may interest the amateur, as well as the serious student of music.

The whole subject is dealt with in seven chapters. In the first introductory chapter, some of the basic facts regarding the nature and perception of sound are set out. The second chapter on tuning forks and pure tones gives an account of the elementary theory of harmonic motions and the result of their superposition. Chapter III deals with the physical principles of stringed instruments. In Chapter IV, the vibrations of columns of air and the theory of musical instruments depending thereon, *e.g.*, organ pipes, flutes and clarinets are considered. In Chapter V, the theories of harmony and the origins of the musical scale are dealt with. Chapter VI gives an account of the important subject of auditorium acoustics. Chapter VII which concludes the book discusses the part played by the physical and physiological laws of hearing in the appreciation of music.

Besides drawing freely on the classical treatises of Helmholtz and Lord Rayleigh, Sir James Jeans has also made use of the information contained in the more modern treatises and the technical and scientific journals. The material selected has been re-written in simple language. The book should therefore appeal to a large class of readers who desire to learn something of the scientific basis of music with the minimum of personal effort.

The book traverses much ground which is naturally quite familiar to the professional physicist. Nevertheless, Sir James Jeans' well-known gift of exposition gives a touch of interest and novelty even to what is well known and makes the reading of the book both pleasant and profitable. The excellent get-up of the book and the well-chosen illustrations help in making it an attractive publication.

C. V. RAMAN.

Reports on Progress in Physics, Volume IV. General Editor: Allan Ferguson. (Published by the Physical Society, London. The Cambridge University Press, London), 1938. Pp. 389. Price to non-fellows 20*s.* net.

The rate of progress in physics at the present time is so great and the output of papers so vast that all physicists engaged in teaching or research must feel grateful to an organisation which undertakes the task of reviewing the published literature and presenting reports on the same once a year. It is well known that the Chemical Society and the Society of Chemical Industry in London have for many years published annual reports on the progress of Pure Chemistry and Applied Chemistry respectively, and that these reports have been most serviceable to a large body of readers, including even physicists. A corresponding series of reports on the progress of physics in the English language was sadly lacking until recently. The enterprise of the Physical Society in undertaking the publication of the same is a matter for congratulation.

The volume under review is the fourth of the new series. It consists of eighteen articles edited by experts in their respective fields. Amongst the subjects dealt with may be mentioned, Sound and Ultrasonics, Heat, Thermo-Dynamics and Refrigeration, Quantum Theory and Atomic Physics, Optical Instruments and Spectroscopy, Electrolytes and Electrolysis, X-Ray Analysis of Molecular Structure and Magnetic Anisotropy of Crystals. These and other topics cover such a wide range that any physicist whatever his field of interest, is sure to find much in the reports to interest him and claim his attention. It should be profitable for a physicist to read even such reports as lie outside his own special field in order to gain some acquaintance with the progress of the science as a whole. A welcome feature found in several of the articles is that they attempt to present a coherent picture of the whole field dealt with. The relation of present progress to past work is thus more clearly appreciated.

The reviewer feels sure that these reports will be welcomed by all English-speaking physicists and will find a place on their shelves.

C. V. Raman.

Physics in Industry. (Published by the American Institute of Physics, New York), 1937. Pp. xiv + 290. Price $1·50.

It is a happy idea of the American Institute of physics to issue in book form a choice collection of ten papers dealing with the rôle of physics in some important industries, that have appeared in the *Journal of Applied Physics* and in the *American Physics Teacher*, for the benefit of the general reader. In a *Foreword* to the book by Prof. K. T. Compton an analysis is made as to who is an Applied Physicist and what are his functions in relation to industry. E. C. Sullivan, Vice-Chairman of the Corning Glass Works, discusses in his paper on the 'Glass Industry' the developments made by the technical physicists who outnumber the chemists in his Works, in maintaining the quality of products, in improving the manufacturing methods and in developing new varieties of glass. In the second paper, 'Physics in the Metal Industry,' Zay Jeffries and E. Q. Adams describe the applications of physics in geophysical prospecting of metals and in mining and smelting operations. Paul D. Foote takes the reader through a course of physics pertaining to lubrication oils in 'Petroleum Industry'. In his masterful narrative he develops the theory of viscosity and the practice of lubrication side by side and suggests innumerable problems in the liquid state and surface phenomena for the applied physicist, on the solution of which depends the elimination of many troubles in the automobile industry. J. P. Den Hartog indicates the great importance of physical investigations of the problem of 'Vibrations in Industry' which has assumed serious dimensions in recent years in connection with the development of high-speed Diesel Engines and Steam Turbines. The rôle of the physicist in improving human comforts in 'Buildings' is brought out in another paper by John Ely Burchard. The three articles on the 'Communication Industry' by O. E. Buckley, 'Aeronautics' by C. B. Millikan and 'Electrical Power Industry' by Joseph Slepian deal with problems which are essentially born out of recent fundamental developments in physics and several points of interest to the industrialists, inventor, and investigator are contained in them. The last two papers contributed by Holmer

L. Dodge and A. R. Olpin discuss the problem of 'Training of Physicists for Industry' the former from the point of view of the educator and the latter from the point of view of the employer. These two papers are of special importance as they are based upon vast experience of the authors and extensive enquiry conducted by them with a view to bring the educator and the employer together and plan an acceptable course of applied physics for the future. A perusal of the book is highly instructive and is recommended to industrialists and technologists interested in higher education and in the development of applied sciences in relation to industries. C. S. V.

Physikalische Methoden im Chemischen Laboratorium. (Verlag Chemie, Berlin), 1937. Pp. 267 : 89 Plates and 38 Tables. Price 2·70 R.M.

With the advent of X-rays and modern spectroscopy, the trend of physics has been more and more to elucidate the micro or ultimate structure of matter with the aid of a number of new discoveries and methods. An important aspect of this problem, namely, the structure of molecules has been, however, the specialised study of generations of chemists, who have been able, by a systematic examination of the chemical reactions which the aggregates of molecules undergo with each other, to unravel the constitution of several thousands of molecules. The newer physical methods of investigation, such as X-rays and electron diffraction, infra-red and Raman spectra, dipole moments, etc., have now placed in the hands of the chemists some powerful tools with which to verify more directly their conclusions, or to decide between several possible alternatives which frequently crop up, and conversely to employ these methods for analytical purposes of detecting and estimating the presence of known substances.

The volume under review is a republication in a collected form of a number of articles that have been appearing in serial form in *Angewandte Chemie* since 1928, under the caption "Physikalische Methoden im Chemischen Laboratorium". Twelve of the 13 articles comprising this volume were published only during the last two years, 1936–37, and this fact coupled with the authority of the contributors to write on their respective subjects must be a sufficient recommendation for this publication. The articles are written in a manner to interest both the academic and the technical type of readers and contain copious references to original literature. Nine of the articles deal with the modern analytical methods of spectroscopy, photoelectric spectrophotometry, colorimetry, chromatography, and polarography, and the remaining four with the applications of X-rays, Raman spectra, dielectric loss measurements and ultra-sonic effects to chemical problems. M. A. G. RAU.

Perspectives in Biochemistry. Edited by Joseph Needham and David E. Green. (Cambridge University Press), 1937. Pp. viii + 361. Price 15/.

This is a collection of thirty-one essays on Modern Biochemistry presented to Sir Frederick Gowland Hopkins on the occasion of his seventy-fifth birthday, by the past and present members of his laboratory. These essays deal with a large range and variety of subjects and discuss the varied aspects of the science of life in relation to human welfare.

Professor Hopkins is the great founder and the inspiring guide of the foremost school of Biochemistry in Cambridge. His Institute attracts numerous workers from all parts of the world, and his catholic outlook and wide interest in the field of Biochemistry is reflected in the numerous lines of work which he has inspired at his laboratory. In every one of these essays, the reader will readily discover the "Hopkins touch"—a great tribute to his creative genius.

The future of biochemical thought and discovery regarding which most of the authors have allowed themselves to speculate, constitutes the most stimulating portion of the book. The eighty-fifth birthday of Professor Hopkins which we shall all celebrate in an equally fitting manner, will be the occasion to show that a good portion of the "speculations" have been experimentally substantiated.

This is a most inspiring volume which should be read by all students of biochemistry and biology. M. S.

Qualitative Analysis by Spot Tests. By Fritz Feigl. (Nordemann Publishing Co., New York), 1937. Pp. ix + 400. Price 30/- net.

The systematic study of micro-methods for the identification of inorganic elements and radicles and of organic groups, is of comparatively recent development. Progress in this field has been slow, mainly on account of the difficulty in discovering reagents, sufficiently sensitive and specific, to be of value in characterising an element or a group, in the presence of other elements or groups. The study of specific reagents has been associated with the name of Prof. Fritz Feigl of the University of Vienna and his book embodying to a large extent, the tests developed either by himself or under his direction, is perhaps the most important and comprehensive work on specific reactions and spot tests. It is appropriate that an English translation of a section of his work should have been issued and made available to a wider circle of analysts.

The merits of the micro-methods are too well known to need elaboration. Two types of qualitative tests are widely recognised: (1) The crystal formation test (using the microscope) and (2) the spot test. The biologist and the geologist are familiar with some of these tests; thus the petrologist examines crystals under the microscope for identifying them by their shape, colour and optical properties; the cytologist is familiar with the stain reactions for identifying cellular constituents. The chemist, however, has succeeded in systematising the subject and to-day, spot tests find wide application in the laboratory. Thus, under Section 7 of the book under review, no less than 55 applications have been listed, including analysis of water, detection of wood preservatives, identification of pigments used in paintings, etc. To this list, additions like the detection of food adulterants in which spot tests have proved invaluable, have to be made. The tests are incredibly simple to carry out and in the hands of an *experienced* chemist, can be almost infallible. The tests have proved exceedingly useful to biologists, geologists and medical men.

The book consists of 8 sections. The apparatus required for the tests is generally available in every laboratory, or can easily be made from material available in the laboratory. Sections 3 and 4 are devoted to tests for individual metals and acids. The interfering ions are listed under each test, and so also the values of sensitivity (using Schleicher and Shüll spot filter-paper); details for the preparation of the reagents for each test are also given. It is surprising to find the omission of thiourea test for bismuth. The test is specific (molybdenum may interfere) as bismuth gives, with thiourea, a yellow colour, while other metals give only white precipitates; bismuth can be detected in concentration of 1 part in 500,000. In applying the Gutzeit method for arsenic, the test can be made specific to arsine by treatment of the test spot with hot concentrated hydrochloric acid. The colouration due to stibine and phosphine disappears while that due to arsine is intensified to a brick red. An extremely valuable reagent for detecting iron, to which reference is not found in the book, is thioglycollic acid, first suggested by Lyan in 1927. Ferrous thioglycollate which is colourless in neutral or acid solution gives a strong purple colour in ammoniacal solution and as little as one part of Fe in ten million parts can be detected by this colour test. Chlorides, sulphates, fluorides and phosphates have no effect.

Section 5 is devoted to a description of the systematic analyses of mixtures. The Gutzeit's and Heller and Krumholz' procedures are described in necessary detail. Heller's procedure for the analysis of alloys is also included in this section.

The application of spot tests in organic chemistry, classified under (1) detection of elements, (2) identification of characteristic organic groups and (3) identification of specific organic compounds, forms the subject-matter of Section 6. The author has stated that the detection of organic compounds is usually less reliable and less definite than the detection of inorganic compounds. Much remains to be done in this field and further development is much to be desired. Attention may be drawn to an error under tests for enzymes on p. 316; it is mentioned that polypeptidases may be recognised by their breaking down diketopiperazine to glycocoll or glycyl-glycine. This is obviously an erorr; polypeptidases specifically hydrolyse polypeptides.

The book will be welcomed, as a very important addition to the literature on micro-chemistry now available in English.

Maintenance of High Speed Diesel Engines. By Arthur W. Judge. (Chapman & Hall, Ltd., London, 1938, Pp. 254. Price 13/6.

This book first published in 1936 now revised and enlarged, forms a good companion volume to "High Speed Diesel Engines" written by the same author. The book is profusely illustrated with leading types of Engines and contains valuable information regarding the construction of the Engines and the parts. The author has taken great pains to collect the information on the more recent servicing methods and equipment which will be required by practical men in charge of the transport vehicles. The use of I.C. Engines for transport is making rapid progress and engineers connected with the transport service will find the book, specially the chapter on reboring of cylinders and grinding of valves and valve seatings and the very comprehensive chapters on fuel injection system and timing the fuel pump, very useful. E. K. R.

Cryptogamic Botany. By G. M. Smith. Vol. I—Algæ and Fungi. Pp. 545; 24/-. Vol. II—Bryophytes and Pteridophytes. Pp. 380; 18/- (McGraw-Hill Publishing Co., Ltd., London.)

This is a most welcome addition at the present moment to the literature on Algæ, Fungi, Bryophytes and Pteridophytes. A comprehensive and up-to-date book of this type intended for the advanced student has been a long felt want. Much information is condensed in these two volumes so that they serve more or less as reference books. As the author himself mentions in the very first sentence of his Preface, "The book is designed for students who have had an introductory course in Botany and who wish to make a more detailed study of plants below the level of seed plants".

The first chapter is a brief one dealing with the classification of spore-producing plants. In spite of the brevity, a number of controversial points concerning the phylogeny of various groups are mentioned.

The second chapter—a lengthy one—deals with Chlorophyta and is treated in a masterly manner. The treatment of a Englenophyta after Chlorophyta is not a desirable sequence. Then follow Phyrrophyta, Chrysophyta, Phæophyta, Cyanophyta, Rhodophyta, Myxothallophyta, Fungi and Lichens.

Although the auther has treated the algal groups in a way open to discussion, the rest of the book is free from such a complaint. In the chapters on Fungi some very important points which should have been discussed at length like the phylogeny of the Ascomycetes have been simply passed over.

The Second Volume deals with Bryophytes and Pteridophytes. The only complaint that can be made against this volume is that the whole matter is dealt with rather briefly. Out of 362 pages, not including the Index, 113 pages have been allotted to the Bryophytes. The literature cited is extensive.

Both the volumes contain numerous excellent figures, and typographical errors are entirely absent, as is in keeping with the traditions of the Publishing Company.

On the whole, the book can be said to be unique in its sphere and the author is to be congratulated on his successful attempt.

V. S. Rao.

Herbals: Their Origin and Evolution.—(Second Edition). By Agnes Arber. (Cambridge University Press, London) 1938. Pp. 326. Price 21*s*. net.

In the second edition, the authoress has revised the book in the light of re-orientation of her outlook during a quarter of a century since the book first appeared in 1912. She has reproduced the book in a new form. Sections dealing with botany in Spain and Portugal and the origin of herbaria are important additions to the new edition. In 326 pages consisting of nine chapters on—(1) The early history of Botany; (2) The earliest printed herbals; (3) The early history of the herbal in England; (4) The botanical renaissance of the sixteenth and seventeenth centuries; (5) The evolution of the art of plant description; (6) The evolution of plant classification; (7) The evolution of the art of botanical illustration; (8) The Doctrine of Signatures, and Astrological Botany; (9) Conclusions; together with 26 plates and 131 text-figures and three appendices on (1) A chronological

list of the principal herbals and related botanical works published between 1470 and 1670; (2) An alphabetical list of the historical and critical works consulted during the preparation of the book; (3) A subject index to appendix and a general index,—the evolution of the *printed herbal* during a prolonged period of two centuries between the years of 1470 and 1670, by no means an easy subject of investigation has been ably dealt with, mainly from a botanical and partly from an artistic standpoint. Mrs. Arber, well-known as she is for her botanical publications, should be congratulated for the trouble she has taken and the labour she has put in to rewrite the book in the present expanded and admirable form. The new edition is a boon to the students interested in the history of botany and systematic botany and will undoubtedly prove to be a valuable addition not only to the libraries of botanical institutions, but also to those dealing with the literature on art and science. The quality of printing, the illustrations and photographic reproductions including the binding,—are worthy of the high standard of the Cambridge University Press.

K. Biswas.

The Essentials of Human Embryology. By G. S. Dodds. (John Wiley & Sons, Inc. New York; Chapman & Hall, Ltd., London.) Second Edition, 1938. Pp. vii+316. Price 20/-.

In this, as in the first edition, the author has kept in view primarily the needs of the medical students; and indeed he has thoroughly succeeded in presenting the complicated phases of developmental phenomena in an easily assimilable form by students of Human Anatomy in particular and of mammals in general. The excellently chosen illustrations accompanying the text have been executed with great care. The more important results of recent research on the Reproductive System, "the early stages of development, the ages of the embryos and the placenta, the development of the bone, the pharynx and its derivatives, vascular system and growth of nerves" have been incorporated. In view of the clinical importance of blood conditions, the account of the development of blood cells may have been treated in greater detail.

An account of the developmental anomalies associated with various organ systems forms a commendable feature of the book. The book is strongly recommended for use in medical colleges in India. A. S. R.

Systèmes de rèférence et de movements (Physique classique)—III. Mécanique Newtonienne et gravitation; IV. Le système absolu de la méchanique; V. L'optique des corps au repos; VI. L'optique des corps en movement; VII. L'esprit de la science classique. By Augustin Sesmat. (Actualités Scientifiques at Industrielles, Nos. 481–85.) (Hermann et Cie, Paris), 1937. Pp. 72. Price 12 *fr.*

The idea of an absolute time and of an absolute frame of reference with respect to which the motions of material bodies in the universe could be described in terms of a few principles (embodied in Newton's famous laws and his law of gravitation) was the dominating idea of classical physics. This idea acquired an additional importance on account of the method of "explanation" of physical phenomena—a method which seeks to envisage every physical phenomenon as the visible manifestation of motions of some ultimate entity or entities. Thus heat came to be explained in terms of the motions of molecules, sound in terms of the vibrations of material bodies, light in terms of the vibrations of an ether, and, in Maxwell's theory, electromagnetic phenomena in terms of the motions of the same ether. But the idea of an absolute frame of reference came up against serious difficulties with the development of the electromagnetic theory and the advent of Relativity marked its final disappearance from physics. The history of the development of the idea and of the efforts to fit into its scheme the ever-increasing array of physical discoveries is a fascinating study and M. Sesmat has presented to us in his book an admirable account of the subject. The principles of Newtonian mechanics and of universal gravitation are first set forth and the striking success of the theory, both terrestrial and astronomical, are then exhibited. The next step inevitably takes us into the domain of optics and electromagnetism, and we are led through the successive stages of the development of the wave theory and

of the electromagnetic theory, culminating in the Michelson-Morley experiment and the theory of Lorentz. From Newton to Lorentz we are shown the unfolding of a single picture, skilfully and strikingly delineated. An extensive Bibliography given at the end of the work bears testimony to the wide scholarship and erudition of the author.

While the author's account of the historical development of basic physical theory is eminently readable and attractive, it is not so easy to subscribe to his thesis of the existence of an "absolute frame of reference" and of an "absolute and universal time," with respect to which actual bodies in the universe move in accordance with classical mechanics. His definition of such a frame of reference depends on the postulate of a finite universe with a finite number of material particles, of a First Moment in world history and of an initial world-state in which all its particles are at rest. It is clear that such a definition is metaphysical rather than physical. This becomes even more evident when we find that after discussing the issues raised by the Michelson-Morley experiment with its null-result, the author asks "Que pent-il rester alors de nos conclusions anterieres?" and concludes that "tout l'essential encore..Notre premiere conclusion demere donc intacte." Naturally. Not being an idea with physical content, it is unaffected by the results of physical experiments! In the last volume a philosophic evaluation of classical physics (in the light of the above-mentioned thesis) is attempted. Here the author introduces a classification of physical magnitudes into what he calls "intrinsique" and "relationelle". The mass of a material point and the relative velocity of two points are cited (among others) as examples of the distinction. The distinction appears to be ambiguous. What, for example, is the meaning of the statement that the mass of a particle is supposed to be given absolutely apart from its "measure" expressing a particular kind of its relation to other particles? No doubt such an intrinsic property underlies the idea of "mass" as a physical magnitude but it is irrelevant to physics. Again, the length of a solid body is classed as "intrinsic" while the distance between two points is said to be "relational". May we not consider the length of a solid body (*e.g.*, a straight rod) as the distance between its endpoints? In regard to the question of Time, as might have been expected, the author adopts the idea of absolute time and of absolute simultaneity: "Notre definition du Temps physique..impliquent la thèse de l'unicité". It might be so, but one wonders if the 'time' referred to here is, in Eddington's words, the Astronomer-Royal's time. Apart from a dogmatic affirmation of the universality of time, no thorough-going discussion of this fundamental question is attempted. Indeed the author is unable to overlook the introduction of "local time" in Lorentz's theory, but dismisses it with the remark "il n'est pas le temps objectif, et nous n'avons pas à l'envisager ici". The question is whether this "le temps objectif" of the author is really physical time in the sense in which it is commonly used in Physics.

V. R. T.

An Introduction to Physical Anthropology. By E. P. Stibbe. With an Appendix by W. A. Smart, B.Sc. (Edward Arnold & Co., London.) Second Edition. Pp. vii + 228. Price 10*s.* 6*d.* net.

This volume forms a valuable addition to the literature on Physical Anthropology. Realising that Physical Anthropology has to deal with man essentially as an animal, the author has considered the subject from three view-points: (1) Comparative Anatomy, (2) Palæontology and (3) Anthropology. The author who has had the benefit of expert advice of Professor Le Gros Clark and Dr. A. H. Munter, has succeeded in treating the subject in an extremely interesting manner. This volume will be helpful to all human and comparative anatomists interested in Physical Anthropology. The anatomists in Medical Colleges in India will find in this volume much that would stimulate research in Physical Anthropology. In Part IV of the book, the author has given a clear account of the methods adopted in practical work, in both the field and laboratory. The Appendix in which is embodied a note on the statistical examination of anthropometric data by W. A. Smart, enhances further the utility of the book. The Glossary of technical terms is helpful and the book is well indexed. This book will form a valuable addition to libraries of Medical Colleges in India.

A. S. R.

Coconut Research.

WE are indebted to the Madras Presidency for a considerable proportion of our knowledge of the Coconut palm and it is an interesting coincidence that the work under review* appears just fifty years after the publication of the little monograph of J. Shortt (Madras, 1888), and fifteen years after that of Sampson's well-known book, which also originated in Madras.

Literature on the Coconut palm and its products is abundant but widely diffused through a variety of journals all over the world, in scientific periodicals, technical papers, reports of Departments of Agriculture and the like; to a worker in any one country the original articles are often not readily available and the publication of a new collected work on the palm must always be of interest. It is a disappointment, therefore, to find the present monograph hardly adequate as a review of available knowledge, and to this criticism further reference will be made. The volume is nevertheless welcome for its presentation of the considerable amount of data collected at the four Coconut stations of the Department of Agriculture, Madras, during the past eighteen years, since much of this data had not been previously published, and since what had been published was mostly not easily accessible to the general reader.

That the volume gives most prominence to the industry and research in Madras is perhaps not a cause for criticism. The complaint was levelled against the two earlier editions (1914 and 1921) of E. B. Copeland's classic *The Cocconut*, that the Philippines were therein given a prominence not justified by the status of their coconut industry. In the third edition (1931) Copeland amply justified his procedure in that his work took as its basis the physiology of the palm, which is the same all over the world, and the author of the present monograph could make somewhat the same claim. Thus the botanical chapters III to VI, especially that on "Floral Biology", contain much interesting new material.

The method of approach to practical problems by which fundamental research precedes applied research, though apparently roundabout, is usually economical in the long run. Broadly speaking, fundamental research provides a working hypothesis upon which the applied worker can base his field trials; as a recent writer expresses it, "It is evident that, equipped with a guiding principle, the applied worker can design his experiments with greater economy than previously and can expect to obtain conclusive results much earlier."

Had, then, the author's aim been to present an account of data collected at the Madras Stations (which he does), the reviewer's scope for criticism would have been restricted. Dr. Patel, however, in his Preface, states that the aim is "to present all the available information of importance, incorporating the unpublished results of the research carried out by the Department," and the title of the book, *The Coconut—A Monograph*, surely implies something in the nature of a complete and coherent scientific treatise on the subject. Admittedly an author making a claim like the above is entitled to elaborate the account of the work of his own department, especially where this is being reported for the first time, and in discussing this work in relation to the general body of knowledge to refer the reader to the literature for details of the latter. But this implies the provision of an adequate bibliography. The work under review is equipped with a Bibliography of eight and a half pages containing 194 references, but this is so marred by errors and misprints that its utility is seriously impaired. Lack of care in ensuring the accuracy of literature references is such a common fault in Indian scientific publications and one to which attention is so seldom drawn, that the reviewer feels that he has a duty to Indian science in general to elaborate his criticims on this score in the present instance.

Names of authors are frequently misquoted; Philippine names seem particularly to have suffered in the present bibliography. Aurelio Cruz, for example, appears indexed under A, instead of as *Cruz, Aurelio*; Pantaleon U. Bacomo comes under the P's, instead of as *Bacomo, Pantaleon U.* and so on. By the same error of transposition the Director of Agriculture of British Guiana appears as *Sydney, Dash J!* The well-known publishers of *Tropical Life*, appear in three different styles, the most humorous perhaps being "John Balesons,

* *The Coconut: A Monograph*, by J. S. Patel, M.Sc. (Cornell), Ph.D. (Edin.). Pp. vii+313. (Government Press, Madras). Price Rs. 3-12.

Daniels Sons, Limited," and after two unsuccessful attempts the compiler gives up the attempt to reproduce "John Bale, Sons and Danielsson, Ltd." and refers to *The Tropical Life* Publishing Dept." These are perhaps minor points, though not the only examples which could be quoted. But what can be said of the quotation of Prudhomme's well-known book, published in Paris in 1906, as "*Prudhomme, E.* (1906). Dans les princip aux Pays de production coprah, Huile, fibre de coco et dérivés divers. Par. Paris"? The title-page of the work in question reads "*Le Cocotier.* Culture, Industrie et Commerce dans les Principaux Pays de Production. Coprah, Huile, Fibre de coco et Dérivés divers. par E. Prudhomme." It would suffice to quote simply "Le Cocotier", without the subtitles. The author has perhaps been wise in not giving a single other reference (one to a Tamil work excepted) to a non-English publication, not even to the essential works of Preuss and Hunger. Even worse is the confusion in one or two references between *The Tropical Agriculturist* (published in Ceylon since 1881), and *Tropical Agriculture* (published in Trinidad since 1924). Neither is there much to be said for the eleven references to *The Experiment Station Record* (the abstracting journal of the U.S. Department of Agriculture), since in these cases references are not given to the original articles. It is, moreover, very common for periodicals dealing with Tropical Agriculture to reprint articles from other journals concerned with the same subjects. This has led the author to give two or more references to one and the same article in more than one instance. Not that there is great harm in this. Workers in the tropics generally have very limited library facilities and in such cases may have available a journal in which a particular article has been reprinted or abstracted, and not that containing the original article. But surely it is better for the bibliographer to exercise a little care and to aim at some standard of literary exactness. In referring to a particular article, the original reference should be given first, followed by references to reprints of the article in other journals and then by reference to summaries in abstracting journals. For example :—

Galvez, N., Moreno, R., and Lava, V. G., (1928), Chemical Studies on coconut products. II. Utilization of the coconut. *Philippine Agric.*, 1928, **17**, 163–68. Reproduced in *Trop. Agriculturist* (Ceylon), 1928, **72**, 41–44. Abstr. in *Chem. Abstr.*, 1929, **23**, 295.

Other faults noticed have been occasional omission of page numbers, incorrect spelling of foreign place names, and some confusion in titles of journals, when, as often happens, these have been altered by the publishers at some stage of their history. Thus the *Malayan Agricultural Journal* appeared from 1912 to 1921 as the *Agricultural Bulletin of the Federated Malay States.*

The reviewer, in thus elaborating the often minor faults of the bibliography in the book under review, does not intend to imply that it is an outstandingly bad one of its kind. Many worse have come to his notice, and he recollects a particular, rather pretentious, work which achieved the masterpiece of four gross errors in a single line of literature reference. Rather does he wish to do a service to Indian science by suggesting that the value of published work can be much increased by a little care to avoid inaccuracy.

The present bibliography can, however, be further criticised on the ground of inadequacy; it is nowhere near to being a satisfactory review of the literature. As mentioned above, no reference to important German and Dutch work is to be found at all, nor, except for an occasional mention of Prudhomme (spelled "Prudhoum" in the text), to work in the French Colonies. The limited scope of the bibliography can perhaps be indicated by the fact that of the 194 references, 43 are quoted from the *Malayan Agricultural Journal*, 28 from the *Tropical Agriculturist* (Ceylon), and 25 from the *Philippine Agriculturist*, a total of fifty per cent. from three journals. It is even more striking to mention that a bibliography on the Coconut palm and its products, in course of preparation by a colleague of the reviewer, already contains over 2,500 original references.

One does not necessarily expect such an encyclopædic review; but one is entitled to expect that the author of a scientific monograph shall have exercised some critical faculty in surveying the literature, especially when he claims "to present all the available information of importance". It is unfortunately the reviewer's opinion that the author has not made that extensive survey of the subject which would justify such a claim and his bibliography is in no sense a "selected" one.

The chief value of the book therefore remains in its presentation of some new data. Even here the facts brought forward are not well digested. The author might ponder the following: "A vast number of observations without order or regularity is not unlike a confused heap of stones, lime, beams, and rafters requisite for constructing an edifice, but which being combined with no skill fail in producing the proposed effect" (T. Bergmann, *De indagando vero*, 1779). For this reason, *i.e.*, a disconnectedness in treatment, the book is by no means easy to read. The author's use of mathematical analysis is commendable, but the general reader will find it heavy going, and the author has not entirely succeeded in his design of presenting, at the end of each chapter, the main conclusions in simple language.

In complaining of the inadequacy of the account of present knowledge, the reviewer is not referring to the omission of fairly recent work. He appreciates that it is impossible to make a book of this nature "up-to-the minute", and that an author must set a time-limit, about 1934 in the present case. Since this date there has been much activity in the field of Coconut research.

Systematic research on the Coconut palm started rather late. The Philippine Islands were early in the field, with the help of American scientists from about 1906, but it is only comparatively recently that other producing countries have organised scientific work. A Research Institute with a full-time staff commenced operations in Ceylon in 1933; the Department of Agriculture, Straits Settlements and Federated Malay States, appointed in 1929 a full-time officer for Copra Research; notable entomological work has been done recently in Fiji; stations in the Dutch East Indies are devoting much time to the study of the palm. Other examples could be given, and it is clear that the next few years will see considerable advances in knowledge.

In the meantime, as the author of the book under review himself points out, there are enormous gaps in our knowledge. On the general subject of manuring, data are scanty and conflicting. Field experiments on Coconut palms take a long time, which is one of the reasons why so few have been started. So far, in fact, only one manurial experiment employing modern technique has been reported, that carried out in Ceylon by Imperial Chemical Industries (India), Ltd., whilst the Coconut Research Scheme of Ceylon, commenced a comprehensive N.P.K. experiment in 1934, after a careful preliminary study of the experimental errors involved in such experiments.

On cultivation methods, still less reliable information is available, and in any case each country will have its own problems related to its own conditions of soil and climate. In several countries controversy rages round the utility of green manures and cover crops, and here again the paucity of information is illustrated by the fact that the present monograph scarcely touches these questions at all.

A popular account of the Coconut palm of a wildly enthusiastic nature in 1914 described coconuts as "The Consols of the East". Technical development and competition in the oil and fat industries have discounted former advantages possessed by coconut oil in the world's markets. In the face of trade depressions, tariff barriers and intense competition the producer has to consider, as he had not twenty years or even ten years ago, how to reduce to a minimum his cost of production. The answer is not to abandon cultivation and manuring, as many have done, regardless of the obligations to future generations which the ownership of land implies, but to evolve, with the aid of scientific research, the most efficient and economical methods of working.

There is a tendency in times of depression to regard research as a luxury. It is, however, false economy in the long run to cut down research expenditure at such times. What is wanted to enable the coconut industry to maintain itself successfully is more research, not less, and more application of the results of research.

The publication of the present monograph, in spite of many faults to which attention has been drawn, will undoubtedly do a great service in calling attention to this need for continued research on the Coconut palm and its products, and in stimulating workers in the same field elsewhere. The reviewer would acknowledge that he has found the perusal of the book provocative of ideas, particularly on the methods of attack on the many outstanding unsolved problems.

The book is, then, one to be welcomed, but it might have been so much better.

R. CHILD.

CENTENARIES.

S. R. Ranganathan, M.A., L.T., F.L.A.
(*University Librarian, Madras*)

Boerhaave, Herman (1668-1738)

HERMAN BOERHAAVE, a Dutch physician, scientist and philosopher, was born at Voorhoat, near Leyden, December 31, 1668. He lost his mother in his fifth year. He was designed by his father for the ministry and hence was made proficient in languages even before he was eleven. But a cancer in his thigh interrupted his studies at this stage for a few years. He then joined the public school at Leyden where he made phenomenal progress, carrying away all the prizes that came his way. When he was about to enter the University, his father died leaving him but slender means to prosecute his studies. But his genius and industry gained scholarships and prizes for him and with their aid he took the degree of Doctor of Philosophy on the basis of a thesis—*On the distinction between the soul and the body* (1689). Then he pursued his scientific studies, mathematics, physics, chemistry, botany and medicine which culminated in another doctorate in 1693 at Herderwick.

After practice in Leyden for a few years, he was elected lecturer of the University of Leyden in 1701. *De usu ratiocinii mechanic in medicina* (1703), *Institutiones medicæ* (1707) and the clear classification, causes, and cure of diseases given in the *Aphorismi de cognoscendis et curendis morlies* (1708) spread his reputation far and wide. His new medical system was widely adopted by his contemporaries.

In 1709, he was elected professor of medicine and botany. In 1710, he brought out his *Index stripuim in horto academico.* In 1718 he occupied also the chair of chemistry and his *Elementa Chemice* was reputed to be the first popular rendering of chemistry in a clear and beautiful style. He published also half a dozen other treatises on subjects like anatomy and materia medica.

When he laid down the office of the Governor of his University in 1715, he made an oration in which he declared in the strongest terms in favour of experimental investigations and rigorous mathematical deductions and showed the futility of purely speculative methods. Some of his contemporaries, steeped in jealousy and envy invoked both by this erudition and by their inability to comprehend his writings, read into this oration an anti-christian attack and made a move to darken his reputation. But the University put down such calumnies with a stern hand and when he was asked what punishment should be meted to his mean adversaries he said, "that he should think himself sufficiently compensated, if his adversary received no further molestation on his account." He used to say of calumny, "They are sparks, which, if you do not blow them, will go out of themselves."

Such interested and judicious attacks on a reputation founded upon solid merit merely helped to enhance it. In 1720 he was elected a member of the Academy of Sciences at Paris. Two years later he was elected a Fellow of the Royal Society of London. His fame extended even to the furthest parts of Asia. It is said that a Chinese Mandarin addressed a letter to him with the superscription "To Boerhaave, Physician in Europe" and that the letter was duly received. When he recovered from a long illness in 1732, the inhabitants of Leyden celebrated the joyful event by a public illumination.

After a long and painful period of illness, Boerhaave died at Leyden, September 23, 1738.

Courtois, Bernard (1777-1838)

BERNARD COURTOIS, the discoverer of iodine, was born in 1777. He employed himself in the manufacture of saltpetre near Paris. In 1811, he discovered iodine accidentally. He reported this discovery to *Annales de Chemie* (1813) in two papers entitled *Decouverte d'une substance nouvelle (iode) dans le vareck* and *Sur un nouvel acide forme aved l'iode.*

In his process for procuring soda from the ashes of seaweeds, he found the metallic vessels much corroded. He traced this effect to a new substance in the bye obtained by extracting the weed with water. He wrote "The mother-liquors of the bye obtained from vareck contain a tolerably large quantity of a singular and curious

substance. It can be easily obtained... The wonderful colour of its vapour suffices to distinguish it from all other substances known upto the present time."

Soon after its discovery, Courtois gave specimens of it to Deormes and Clement for chemical examination. They presented a memoir on it at a meeting of the Imperial Institute of France in November 1813. A few days later, Gay Lussac received a specimen of this substance and after a careful study designated it *iode*. He also prepared and named *hydriodic acid*. Humphrey Davy who was then at Paris received a complementary specimen from Ampere and he confirmed the conclusions of Gay Lussac in a communication sent to the *Philosophical transactions* of the Royal Society in 1814–1815. Mellor records that "H. Davy played a not too glorious part" in the affair.

Courtois died September 27, 1838.

ASTRONOMICAL NOTES.

Planets during October 1938.—Venus will continue to be a very bright object in the western sky soon after sunset, and will attain greatest brilliancy on October 16, the corresponding stellar magnitude being —4·3. On October 30, the planet will be at one of the stationary points of its orbit. Mars will be visible as a morning star, rising about two hours before sunrise, but will still not be well placed for observation. The close conjunction of the planet with Neptune on October 12 is worth observing, the angular distance between the two being only five minutes of arc. A small telescope will however be required for observing the phenomenon.

The two major planets Jupiter and Saturn will be conspicuous objects that can be conveniently seen in the early part of the night. The former is nearly stationary among the stars during the month and will be on the meridian at about 8 P.M. Saturn will be rising at about sunset; and on October 8, the planet will be in opposition to the Sun. The major and minor axes of the ring ellipse are 45″ and 7″ respectively. An occultation of Uranus by the moon will take place at about 10 P.M. on October 11, the reappearance being at the dark limb can be observed even with a binocular. Another lunar occultation of interest that can be seen in these latitudes is that of B. Capricorni, a third magnitude star which will occur at about 9 P.M. on October 3.

A General Catalogue of Stars.—The Department of Astrometry, Carnegie Institution of Washington, has recently published in five volumes, an extensive catalogue, providing standard positions and accurate proper motions of a large number of stars well distributed over the whole sky. The catalogue includes all stars brighter than visual magnitude 7·0 and contains, besides, a number of fainter stars with fairly well determined proper motions. An elaborate investigation on the solar motion, the constants of precession and galactic rotation, has been made by R. E. Wilson and H. Raymond (*Astro. Journal*, 1084) based on the large amount of material contained in the New General Catalogue. Their discussion indicates small corrections to Newcomb's tables of precession. Referred to stars brighter than 7·0 magnitude, they find for the position of the apex of solar motion R.A. 270°·4, Declination 33°·2 N. As is well known, there are marked changes in the position of the apex depending on the magnitude and spectral types of stars whose motions are used in the investigation.

T. P. B.

OUR scientific method has been giving us better and better maps of our universe, mapping it from the points of view of physical science, of biological science, later of sociology, and finally of education. From the philosophical point of view we can not be at all certain that we have made any progress toward an understanding of the absolute nature of things, but we have made a practical progress in these useful guides for our race. The mapping that has been done in the first two fields named has been far more complete than in the others, and therefore is subject to much less criticism.

DINSMORE ALTER.

INDUSTRIAL OUTLOOK.

Industrial Carbon Dioxide from Fermentation of Cane Molasses.

By N. Sreenivasan.

(*The Mysore Sugar Co. Distillery, Mandya.*)

THE problem of the economic disposal of molasses, has been engaging the attention of scientists and industrialists. The production of power alcohol and industrial carbon dioxide offers the most rational and satisfactory solution to the problem; the employment of molasses as a fertilizer is still under experiment.

The dissolution of carbon dioxide in water, results in a sparkling liquid with a characteristic taste, originally discovered by Priestley, and now widely appreciated by the public. With the advent of liquid carbon dioxide and later its conversion into solid, "dry ice", its industrial applications have been greatly extended. The modern tendency is to produce straight the solid carbon dioxide, "Converters" being used wherever the gaseous and liquid forms are required. In America, for example, 90 per cent. of the concerns making liquid till 1923 have changed over to "dry ice" manufacture and at present, there is a production of 700 tons[1] of dry ice per day.

In India the industrial possibilities of the solid product have not been fully explored. Attention may, however, be drawn to the pioneering work of the Dry Ice Corporation of Bombay, which is trying to popularise the use of dry ice for cold storage and cold transport.

Manufacture of Solid Carbon Dioxide.

The fermentation carbon dioxide industry in early days fell into disrepute, because the final product had the bad odour of the raw fermentation gas. With the advent of modern purification process, no stigma rests on the product and in 1929, 348,000 tons of carbon dioxide was produced from the industrial alcohol manufacture in U.S.A.[2]

Of the Backus and the Reich systems of purification, the latter is said to produce the best grade of gas. The first stage in the Reich process is to pass the gas from the fermenter through a "catch-all" with dilute alcohol solution to rid the gas of entrained wash, etc. Next, the gas is well scrubbed and collected in a gasometer and from there, it is compressed to about 75 lbs. per square inch and passed through the next stage of purification. This step comprises the oxidation of organic impurities by passing the gas through dichromate and sulphuric acid scrubbers. Next, the sodium carbonate tower removes traces of the entrained acid and incidentally dries the gas. The final washing is done with compressor oil which removes the impurities produced during the oxidation processes.

Modern dry ice practice insists on a perfect dry gas because of the prematurely formed ice and this is accomplished by silica gel tower. Purified, de-odorised and "bone-dry" gas enters the second stage of compression cycle at a pressure of about 75 lbs. It is compressed to about 420 lbs. per square inch and led through the refrigerating cycle.

The refrigerating cycle best suited for tropical climates is what is technically called a binary cycle, consisting of the CO_2 and NH_3 cycles. The compressed gas under a pressure of 420 lbs. passes through the condenser of the system, which is the evaporator of the ammonia cycle. The carbon dioxide is completely liquefied. Ammonia being a more efficient thermodynamic medium than carbon dioxide, considerable thermal advantage is gained over CO_2; the entire system can be worked at a pressure below 30 atmospheres.

The liquid CO_2 thus formed is passed through an expansion valve into a "snow" chamber where solid CO_2 is formed. The American practice is to subject the solid formed to about 2,000 lbs. pressure and form $10'' \times 10'' \times 10''$ blocks weighing 52–55 lbs. On the Continent, the necessity for pressing the solid is eliminated by an ingenious method followed in the "Carba Process".[3]

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[1] *Chem. & Met. Eng.*, 1933, **40**, 76.

[2] *Carbon Dioxide*, by E. L. Quinn and C. L. Jones, Reinhold Publishing Corporation, New York, 1936.

[3] *Ibid.*, 2.

To provide maximum flexibility for merchantable products, arrangements can also be made for drawing the liquid CO_2 from the condenser into pressure cylinders and sold direct.

Disposal of the Product.

By virtue of its high refrigerating effect, about 278 B.Th.U. per lb., the insulating and desiccating action of the gas evolved, dry ice is eminently suited for refregeration work. Unlike water-ice, the combination of functions of the dry ice can very well be expressed by a new American catchword, *viz.*, "Statifrigeration" or "Coldservation"[4] meaning collectively all the factors involved in keeping a product cold as distinguished from cooling it.

Cold storage and cold transport in India have immense possibilities. The report of the Royal Commission on Agriculture has pointed out the remarkable benefits which refrigeration had conferred on the export and local consumption trades in other countries and recommended that India should adopt similar measures. The preservation of perishable goods in India is a problem affecting millions of agriculturists.

Sir John Russel, in his recent report on Indian Agriculture, has pleaded for increasing the production of fruits and vegetables and for the adoption of cold storage and cold preservation, so that the Indian diet may include more of these essentials of food. The Agricultural Marketing Officer to the Government of India has reported[5] that the quantity of perishables produced annually in the City of Delhi amounts to about 69,000 tons, of which 20 to 50 per cent. is wasted for want of proper storage facilities. The annual output of fruits in Mysore is valued at Rs. 84 lakhs, more than a third of which (about 32 lakhs) is exported.

At present water-ice is being used as a transport refrigerant in small quantities. But, dry ice is better, one pound of which is equivalent to 10 lbs. of water-ice. Freight is thus reduced and there is no untidy melting.

In addition there is a considerable amount of consumption of industrial CO_2 in the baking, confectionery, ceramics, cement, sugar, white lead, mineral water and ice cream industries. The problem of seasonal storage of solid CO_2 is not serious, since storage structures of the order of 3,000 to 4,000 tons are being used by the Dry Ice Corporation of America.[6]

Cost of Production.

A distillery producing 1,550 gallons of 96° Gay Lussac alcohol per 24 hours, for 240 days a year, using the process detailed above, can produce 5 tons of dry ice per day.

		Rs.
1.	*Capital Investment.*—	
	Plant, royalty	2,06,000
	Additional buildings	27,000
	Erection, etc.	13,500
	1,500 steel cylinders for liquid CO_2 (40 lbs. and 20 lbs.)	90,500
	Containers for "dry ice".	13,500
	Total	3,50,500

Say, a maximum of 4 lakhs of rupees.

		Cost per day Rs.	A.	P.
2.	*Daily Operating Cost.*—			
	Power—200 H.P. for 24 hrs. at 0·6 anna per K.W.	135	0	0
	Chemicals (Sulphuric acid, ammonia, soda and water)	50	0	0
	Labour—9 men at As. 12; 12 men at As. 8	19	8	0
	Supervision	15	0	0
	Repairs and Supplies	30	0	0
	Over-head—			
	Depreciation, Interest, Insurance at 20 per cent. of 4 lakhs	335	0	0
	Merchandising—			
	Sales, Commission, Advertisement	20	0	0
	Total	604	0	0

Total production cost per day = Rs. 605.

		Rs.
3.	*Summary of Returns.*—	
	By sale of 2·5 tons of liquid CO_2 at As. 2 per lb., ex-factory	700
	By sale of 2·5 tons of dry ice at As. 1-6 per lb., ex-factory	525
	Total returns per day	1,225
	Total cost per day	605
	Net return per day	620

For 240 working days = 240 × 620 = Rs. 1,48,800.
Net return = 37 per cent. on an investment of 4 lakhs of rupees.

[4] *Ibid.*, 1, 76.

[5] *Report of the Agricultural Marketing Adviser to the Government of India* on "Cold Storage and Cold Transport of Perishables in Delhi," 26th October 1937.

[6] *Ibid.*, 2.

RESEARCH ITEMS.

Resolution of Racemic Amino-acids.—For splitting racemic amino-acids into optical antipodes by the usual Fischer's method fairly large quantities of the alkaloidal salts of benzyolated or formylated amino-acids are employed. To obtain small quantities of optically pure amino-acids by the above method is, however, very bothersome. It has been found that by using active cholestenonsulphonic acid which forms crystalline compounds with amino-acids, the salt of one of the antipodes being more difficultly soluble than the other, ready separation can be effected directly (George Triem, *Ber.*, 1938, **71**, 1522). In this way optical antipodes of leucine, tyrosine, and α-amino-butyric acid have been prepared. With amino-succinic acid the product was optically active though not optically pure.

* * *

Urinogenital Ducts of *Ambystoma tigrinum*.—L. T. Rodgers and P. L. Risley have determined the period in the development of *Ambystoma tigrinum* when the sexual differentiation of the urinogenital ducts takes place (*Journ. Morph., July* 1938, **63**, No. 1). Till a very advanced stage near metamorphosis the indifferent condition in the urinogenital ducts continues, the first signs of differentiation appearing with the formation of the spermatocytes in the male and the oocytes in the female. The differentiation of the secondary sexual characters which make their appearance with the release of the sex hormones by the gonads takes place during or after metamorphosis in the male and before metamorphosis in the female. The post-metamorphic changes consist in the male mainly in an increase in size, in the activity of the epithelia of the ducts. The attachments of the collecting ducts to the wolffian duct shift posteriorly. The females retain the larval condition of the wolffian and collecting ducts. There is an increase in the size of the oviducts also.

* * *

Intestinal Protozoa in Captive Mammals.—At the request of the Secretary of the Zoological Society of London, the fæces of mammals temporarily quartered in the sanatorium of the Zoological Gardens, were examined for intestinal Protozoa and a complete account of it is given by D. L. Mackinnon and M. J. Dibb [*Proc. Zool. Soc. Lond.*. (B), 1938, **108**, 323]. 107 Mammals belonging to 77 species were examined. Commonly cysts of amœbæ were found. These belonged to *Entomœba histolytica, E. coli (?), E. muris, E. bovis (?), E. polecki, Iodamœba* and *Endolimax nana*. Flagellates like *Chilomastix* and *Trichomonas* and cysts of *Giardia* were noted. *Balantidium* sp. and a Coccid probably *Eimeria sciurorum* were also observed in the fæces.

* * *

Chondrocranium and Branchial Skeleton of *Salmo*.—Dr. V. Tchernavin has brought to light many points which were hitherto obscure in the cranium of *Salmo* [*Proc. Zool. Soc. Lond.*, 1938, (B), **108**, 347]. The palato-quadrate is long and possesses an equally long orbital process which reaches the mesopterygoid. Some specimens of *S. trutta* reveal two ossifications upon the mesopterygoid in the orbital process region. The left branchiostegal is better developed than the right. The anterior copula is related to the hyoid and first two branchial arches; the posterior copula bears relation with the three posterior branchial arches. There are two pairs of dentigerous pharyngeal plates. The anterior myodome is differently developed in the several species of *Salmo*. Similarly the mesethmoid; no true mesethmoid occurs in *S. salar* and *S. irideus*. The supraethmoid is free from the true mesethmoid. Some features of the skull of *Salmo*, have undoubted taxonomic importance.

* * *

Fossil Amphibia from Czechoslovakia.—The amphibian fauna of the Carboniferous and permian beds of Czecholsovakia are important not only from the point of view of its richness but also from the view-point of the transition that exists from one bed to another. In an exceedingly important paper, M. C. Steen [*Proc. Zool. Soc. Lond.*, 1938, (B), **108**, Pt. 2] has given an exhaustive systematic account of the four orders, namely, Lepospondyli, Adelospondyli, Labyrinthodontia and Phyllospondyli, a classification based on the nature of the vertebral column. Under the first order, a new species *Ricnodon limnophyes* sp.n. and under the third, four new genera (*Memonomenos, Capetus, Lusor* and *Ptomochoston*) and under Phyllospondyli, a new genus (*Mordex*) and a new species (*Melanerpeton potamites*) are described. *Ricnodon* is tentatively referred to Lepospondyli, from the view-point of the nature of vertebræ while the relationship of the Labyrinthodont *Memonomenos* and *Capetus* are not definitely settled. The Loxommoideæ (Watson) are not ancestral to Rhachitomi and forms a specialised group. The latter undoubtedly exist as an independent one in the upper Carboniferous. The Anthracosaurus possessing Embolomerous type of Vertebræ and considered to belong to Reptiliomorpha by Save-Söderbergh are "identical with those believed to belong to the Loxommids". The Seymouriamorpha while possessing amphibian skull are definitely reptile-like in their vertebral elements. According to the author, the four orders of fossil Amphibia had each an independent origin from a central parent group and Phyllospondyli and Labyrinthodontia are more closely related.

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Development of *Haliotes tuberculata*.—The contribution of D. R. Crofts on the development of *Haliotes* [*Phil. Trans. Roy. Soc. Lond.*, (B), 1937, **228**, 552] throws a flood of light on gastropod ontogeny. *Haliotes* completes its development in about two months and the trochophore lacks apical cilia and a telotroch, but the veliges develops transitory apical cilia. The origin of mesoderm is similar to that in *Patella*. The operculum arises prior to torsion and the asymmetrical velum retractor muscle does not become the columellar muscle and the former is responsible for the first 90 per cent. of the torsion. Growth and migration of the columellar muscle is responsible for the second half of the torsion. The development of ctenidia, nerves and digestive organs is also described. The characters peculiar to *Haliotes* arise when the larva becomes pantigrade. The operculum does not fall away till its function is lost.

A History of the International Geological Congresses.*

By Cyril S. Fox, D.Sc., M.I.Min.E., F.G.S.

Introductory Remarks.

IT is a good argument against any direct descent of a man from apes that these animals have never had intelligence enough to make weapons of stone; but it is a long road in the progress of human civilization since primitive man learned to select material for his stone implements to the day in 1778 when de Luc coined the term *Geology* and de Saussure adopted it a year later. By this time science was already established along several lines for special study, and scientists had learned to appreciate the value of meeting for an exchange of views on their observations and discoveries, and thus it came about that the Geological Society of London was founded in 1807—"....to foster right thinking on the mysterious problems presented by the planet on which we dwell." It was even claimed by the same writer[1] that it was geological "...science which guided the miner to the coal, ...conducted water to our thirsty cities, poured the gold of Africa into the lap of commerce, and discovered diamonds to adorn the fair."

Exploration is the spirit of geology and thus it was that geologists seized opportunities to travel, and in this way, as early as 1824, we find an account of the 'Geology of Russia' by William Strangways who had studied the Volga basin and visited extensively elsewhere in European Russia. However, it was fully understood at that time that such investigations were useful in obtaining a general idea of the geological features of a region, but that geological mapping like topographical surveys, because of the expense involved and the public benefit derived from them, were duties best undertaken by Government. The first State survey of this nature was that of the Geological Survey of Great Britain established in 1835. Its usefulness may be presumed from the fact that it celebrated its centenary in 1935 by being provided with a new building specially designed for its offices and museum in South Kensington. Canada established a Geological Survey in 1842, India initiated its Geological Survey about 1845, and many other countries followed soon after. Three famous geologists—Murchison, De Verneuil and Keyserling were invited by the Tzar Nicholas I to make a geological study of the Ural-Volga region about that period and their results, published in 1845 in two volumes—'The Geology of European Russia and the Ural Mountains'—does not appear to have convinced the Russian Government to establish a geological survey then. It was not till 1882 that the Russian Geological Committee (Survey) was sanctioned and it appears to have been regarded more as an academic luxury than with any hope of usefulness as a return for its upkeep.

With the establishment of geological surveys in most civilized countries since 1835 and the appearance of published reports and maps of areas all over the world, it was quickly noted that geologists even in adjacent countries studying the same rock formations were evolving geological terms which were dissimilar and often confusing. There was in fact a gradual development towards a veritable 'Tower of Babel' in geological classification and nomenclature before 1876 when, after the exposition at Philadelphia, a meeting of the America Association for the Advancement of Science was held on the 25th August 1876, at Buffalo, New York, with Professor W. B. Rogers as President, to consider this matter. A resolution was passed that a committee be formed to endeavour to hold an International Geological Congress at the Paris Exhibition which was fixed for 1878. The Committee was elected the same day at the Buffalo meeting and Professor James Hall chosen as Chairman and Dr. T. Sterry Hunt selected as Secretary. This Committee assisted by geologists in other countries and especially by the Societe Geologie (France) successfully arranged for the first session of the International Geological Congress to meet in 1878 in Paris with the special object of establishing an international geological classification and nomenclature.

First Session in Paris.

At the *First* Session of the International Geological Congress held in Paris in 1878 the President, E. Herbert, in his address complained that geology "...remains a science of the initiated, because it does not yet present in its language that general character possessed by other sciences and facilitating the study of them." He continued—"It is to supply this want that you are assembled here. Science is of no country; there can be among us no rivalry other than that which results from the pursuit of truth." Whether an invitation to attend this first Congress was received in India or not is not now certain, but it is doubtful if any officer of the Geological Survey of India could then have been spared. H. B. Medlicott and W. T. Blanford were then heavily engaged in the preparation of the *Manual*, which was published in 1879, on the Geology of India.

The *Second* Session, with G. Capellini as President, was fixed to be held in September 1881, in Bologna and it was to attend this that sanction was finally accorded to W. T. Blanford who was sent in place of H. B. Medlicott. The proceedings and papers of the Congress were published in two volumes of *Comple Rendu* (Bologna, 1882). Blanford's report is in our Records,[2] but attention is drawn to the elaborate papers by Professors Albert Heim (Zurich) and A. Karpinsky (St. Petersburg) on a standard scheme of signs and colours for geological maps.

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* With the permission of the Director, Geological Survey of India.

[1] W. J. Sollas, at the Centenary Meeting of the Geological Society in London, 1907.

[2] *Rec. Geol. Surv. India*, 1882, **15**, Part 1.

Berlin, 1885.

The *Third* Session of the International Geological Congress was held in September 1885, in Berlin, with E. Beyrich as President. Blanford, who had already retired from the Geological Survey of India, attended the session at which he submitted a ' Note Sur la classification des roches de l'Inde Brittanique'. In this paper, published in the *Compte Rendu* of the Congress, he gives separate tables of the formations in the Peninsular and extra-Peninsular areas. In these he shows he is in agreement with the terms :—*Group* (= Era) divided into *Systems* (= Periods) sub-divided into *Series* (= Epochs) which consist of *Stages* (= Ages) which were suggested at the Bologna (1881) meeting. He includes the Pleistocene (series) in the Pliocene (system) and thus in the Kainozoic (group). His report on the Congress is published in the Records.[3] Professor E. Renevier, who had been detailed at the 1881 meeting to go into details regarding the preparation of a geological map of Europe (1 : 1,500,000) and perhaps the most important matter at the 1885 Congress, produced, with Professor Albert Heim, a splendid report. It gives elaborate details of a colour scheme suitable for sedimentary and igneous rocks and for an acceptable stratigraphical sequence, which is also given in the *Compte Rendu* of this Congress (Berlin, 1888).

London, 1888.

The *Fourth* Session of the International Geological Congress was held in London in 1888 with J. Prestwich as President. We were well represented by W. T. Blanford, V. Ball, R. Lydekker and H. B. Medlicott on the retired list, but we had sent no delegate. Blanford's report as " President of the Geological Society of London on the International Geological Congress of 1888 " was published in our Records.[4] At this Congress special committees dealt with the stratigraphical sequence—Archæan, Lower Palæozoic, Upper Palæozoic, Mesozoic, Kainozoic, Quarternary and Recent, as well as with the ever recurring questions of classification and of nomenclature.

The *Fifth* Session was held in Washington in 1891 with J. S. Newberry as President. There was an important paper on " The Pre-Cambrian Rocks " by C. R. Van Hise among other valuable contributions. The excellent series of excursions evidently formed an attractive part of the Congress meeting as they included journeys to all the notable areas of United States geology. The *Sixth* Session was held at Zurich in 1894 under E. Renevier, whose contribution, ' Chronographe Geologique—Tableau des Terains Sedimentaires formes pendent les epoques de la Phase organique du Globe terrestre, " remains as a classic in geological literature and should be better known. R. D. Oldham[5] attended this Congress after completing the second edition of the *Manual of the Geology of India*.

[3] *Rec. Geol. Surv. India*, 1886, **19**, Part 1.

[4] *Ibid.*, 1889, **22**, Part 3.

[5] The second edn. *Man. Geol. India* was published in 1893.

Russian Meeting of 1897.

The *Seventh* Session of the International Geological Congress was held in St. Petersburg in August 1897, under the presidentship of A. Karpinsky, Director of the Russian Geological Committee. The actual meeting was held in the large hall of the Zoological Museum on the 29th August (17th Aout according to the Julian calendar then used in Russia).[6] The invitation had been given at the Zurich (1894) session in the name of the Tzar Alexander II and the delegates were welcomed by the Grand Duke Constantine on behalf of the Tzar Nicholas II who granted free first class travel in Russia to all the delegates attending the 1897 session.[7] C. L. Griesbach had been recommended as the official delegate from India, but was unable to attend the Congress. F. R. Mallet and Philip Lake who had retired from the Geological Survey of India, were present at the meeting in St. Petersburg and the former had already attended the excursion to the Urals before the Congress meeting. The other excursions before the Congress were to Finland and Esthonia then still part of Russia.[8] After the Congress there were excursions to the Caucasus, Asia Minor, the Black Sea and Crimea. Everywhere the delegates received a hearty welcome, receptions by local authorities, numerous lunches and banquets of the most lavish description. According to some of the visitors, the social functions took too large a share of the time of the excursions.[9]

The discussions at the Congress were largely confined to (1) the adoption of definite principles for the classification of rocks and for petrological nomenclature generally ; (2) the establishment of rules to govern the introduction of new terms in stratigraphical nomenclature ; and (3) the conclusion that it was better to maintain a stratigraphical classification on an artificial basis until more data were available to establish it on a natural basis.

Since many of the excursions of this Congress were to form the nucleus of those conducted in 1937 it is of interest to record that pamphlets were issued to assist the delegates. The general descriptions and geological sections were good and satisfactory but there was some criticism regarding detailed particulars and that some mine sections did not correspond with visible exposures. In the case of the Urals excursion the journeys included a trip on the Volga at the famous Samara bend and visits to the limonite mines of Bakal, the works at Simsk, the magnetite deposits of Wyssokaia and Blagodat (near Nizhny Taghilsk) ; the famous malachite occurr-

[6] The Soviet Government adopted the Georgian calendar as from February 14, 1918.

[7] Nicholas I invited Murchison to examine the Donetz coalfield and the Urals region. Nicholas II was the Tzar who abdicated in March 1917.

[8] Both these areas had been seen by Strangways in 1822 and Murchison in 1841.

[9] Charles Palache (*American Naturalist*, November 1897, p. 954). Among other papers referring to this Congress see also *Am. Jour. Sci.*, 1897, **4**, 477 ; *The Mining Journal*, 1897, **47**, 1162 ; and *Nature*, 1897, **56**, 104.

ence of Mednorondiansk; the platinum placer of Platina; the gold washings of the Miass area; the gold veins of Beresof; and then the return *via* Perm and a steamer trip down the Kama to the Volga and up to the old Tartar town of Kazan. At that time the Russian Geological Survey (Committee) had a cadre of about 20 geologists and budget allowance of barely £20,000 which was more than that of the Geological Survey of India but not so well provided for. We had published a paper by J. B. Mushketoff[10]—'The Geology of Russian Turkistan'—in our *Records* and a few years later were to publish another by Th. Tchernychev[11]—'The Upper Palæozoic formations of Eurasia.'

PARIS EXHIBITION MEETING, 1900.

The *Eighth* Session of the International Geological Congress was held at the time of the Exhibition in Paris in 1900 with Albert Gaudry as President. The veteran Dr. Blanford represented India. Professor J. Joly read his paper 'The Age of the Earth by the Sodium in the Sea' at this Congress. The subject of stratigraphical classification still continued to receive attention and such terms as *Era* (*e.g.*, Palæozoic), *Period* (*e.g.*, Carboniferous), *Epoch* (*e.g.*, Mid Devonian), *Age* (*e.g.*, Bartonian) and *Phase* (= Zone, *e.g.*, *Productus horridus*) were evidently widely used as the time equivalents for Group, System, Series, Stage and Zone, respectively.

The *Ninth* Session was held in Vienna in 1903 under Emile Tietze as President. C. L. Griesbach, late Director of the Geological Survey of India, and the late T. D. La Touche were present as the representatives from India. Griesbach read a paper on the Exotic Blocks of the Central Himalaya (Chitichun and Balchdhura) in which he supported von Krafft's theory of 'carriage' by lava floods than that of a possible development of over-thrust phenomena. T. L. Walker and C. Diener, who had both been into the area discussed, were not in agreement with the views put forward by Griesbach. La Touche considered the ideas of Klippen and Nappes put forward at the meeting—by Von V. Uhlig (Uber die Klippen der Karpaten), W. Killian (Les phenomenes de Charriage), Maurice Lugeon (Les grades Nappes de recouvrement den Alpes Suisse) and Arthur Keith (Fold Faults of the South Appalachians)—were of local geological interest though they attracted considerable attention at the meeting. There was also an interesting paper on the 1902–03 Eruptions of Mt. Peleé, Martinique, and the Soufriere, St. Vincent, by E. Otis Hovey.

The Tenth Session of the International Geological Congress was held in 1906 in Mexico City under José G. Aiguilera as President. We sent no delegate to this Congress. There were excellent papers by Dr. Tempest Anderson on the 'Recent Eruptions in the West Indies, St. Pierre (Mt. Peleé)' and 'The Eruption of Vesuvius'; and by Edgeworth David, J. W. Gregory and E. W. Hilgard (on glacial climates, climatic variations and causes of climatic changes) and also by W. Lindgren (on the relation of ore deposits to physical conditions).

[10] *Rec. Geol. Surv. India*, 1887, **20**, Part 3.

[11] *Ibid.*, 1904, **31**, Part 3.

STOCKHOLM MEETING.

The *Eleventh* Session was held in Stockholm in 1910 with G. de Geer as President. After reconsideration the Government of India sanctioned the deputation of Dr. L. L. Fermor as the representative from India. His report[12] is published in our *Records*. Dr. G. E. Pilgrim put up a note on the climatic changes in India (due to the Pleistocene glaciation) for the Congress. The chief objective of the Congress was the preparation of a *Summary on the Iron Ore Resources of the World*. This was published subsequently and includes the information put together by La Touche and a note by Sir Thomas Holland. The importance of economic geology at these Congress meetings may be taken as recognised at this Stockholm session. Among other valuable contributions were papers on the 'Iron of Ovifak and Native Carbon' by C. Benediks. 'The Experimental Investigation of the Flow of Rocks' by F. D. Adams, 'A Criticism of the Quantitative Classification of Igneous Rocks' by W. Cross, and a brief note by C. R. Van Hise on 'The Influence of Applied Geology and the Mineral Industry upon the Economic Development of the World'.

CANADA, 1913.

The *Twelfth* Session of the International Geological Congress was held in Toronto in 1913 with F. D. Adams as President. L. L. Fermor was again selected as the official delegate and represented India at the meeting. Sir Thomas Holland, who was also present, contributed an important paper on the Archæan and Purana Groups. A. F. Molengraaff also sent a valuable paper on 'Folded Mountain Chains, Over-thrust Sheets and Block Faulted Mountains in the East Indian Archipelago'. M. S. Maso and W. D. Smith's contribution on the 'Relation of Seismic Disturbance in the Philippines to the Geological Structure' was also of great importance. They showed that (1) there was a relationship between seismic disturbances and geological structure, (2) the majority of earthquakes are of tectonic origin in the Philippines region at least, (3) Volcanoes are secondary phenomena, and (4) the area of greatest seismicity in the Archipelago is in the Agusam valley, Mindanao. The chief objective of this Toronto session was the preparation of a *Summary on the Coal Resources of the World*, towards which Sir Henry Hayden, Director, Geological Survey of India, contributed the information from India and the adjacent countries. Finally, the meeting considered the question of a geological map of the world on a scale of 1 : 1,500,000—the same as that of the geological map of Europe—put up by Em. de Margerie. It was suggested that the six Asiatic sheets should be prepared by the joint efforts of the Geological Surveys based on Calcutta and St. Petersburg. Then came the War and no sessions were held till 1922.

SESSIONS AFTER THE WAR OF 1914–18.

The *Thirteenth* Session of the International Geological Congress was held in Brussells in 1922 with J. Lebacqz as President. Dr. (now Sir)

[12] *Rec. Geol. Surv. India*, 1912, **41**, Part 4.

Edwin Pascoe was selected to represent India at this Congress which was important for the renewal of the exchange of views after nearly a decade. Among the more important contributions were papers by P. Bertrand (Geology of the Carboniferous), Charles Jacob (French Indo-China), L. Dudley Stamp (The Tectonics of Burma), W. H. Wong and A. W. Grabau (Carboniferous of China), H. Hausen (Physiographic development of the Sino-Siberian Continental Area), D. Mushketov (A Study of the Tian Shan) and David White (Public Geology and National Mineral Wealth).

The *Fourteenth* Session was held in 1926 in Madrid with Cesar Rubio as President. L. L. Fermor was again selected as the official delegate to represent India and visited Teneriffe on one of the excursions. Unfortunately, the collection of rocks and minerals which he made and despatched to India were lost when the M. M. Fontainebleau caught fire and was scuttled in Djibuti Bay where she still lies. Vulcanism was an important subject at this Congress, but there were also valuable papers on the Geology of the Mediterranean, the Geology of Africa, Thrust-faults in the north islands of the Adriatic, and problems of ore genesis. However, the chief effort to revive the economic aspect of the meeting was the preparation of a valuable compilation on *The World's Resources in Phosphoric Acid and Pyrites.*

South Africa, 1929.

The *Fifteenth* Session of the International Geological Congress met in 1929 in Pretoria with Dr. A. W. Rogers as President. Sir L. L. Fermor once again represented India and his great experience was of considerable value during the meeting to decide where the next session should be held. He had prepared a note on the Indian Goldfields as our contribution to the great objective of the Congress—the issue of a statement on *The Gold Reserves of the World.* While gold was perhaps the main theme of the session, careful consideration was given to a proposal to construct a Geological Globe of the world on the one hand and there was also no lack of interest in such valuable papers as ' The Karoo System ' by A. L. du Toit and ' Rift Valleys' by J. E. Wayland, etc., on the other. After this meeting there was also an interesting communication by P. Kovaloff on ' The Reorganisation of the Russian Geological Committee '. It must be mentioned also that the invitation from the Soviet Government to have the next session in Moscow was submitted during this South African Session, and, on a claim of priority from the United States, had to be reserved for acceptance after the American Session.

Washington, 1933.

The *Sixteenth* session was eventually held in 1933 in Washington with W. Lindgren as President. We were unable to send a representative owing to the financial stringency which prevailed in India as elsewhere at that time. Sir L. L. Fermor, however, compiled a note on ' India's Copper Deposits ' for inclusion in the brochure on *The Copper Resources of the World* which was to be the chief production of the Congress. As in the case of the earlier American Congress of 1891, perhaps the most attractive feature of the 1933 session, was the choice of interesting excursions to famous areas of geological importance. In the 42 years which had elapsed since the previous meeting in Washington the Geological Survey of the United States had steadily developed until it was recognised as the finest and best equipped organisation of its kind. Added to this was the knowledge that geological surveys were also organised by various States, and since a vast literature was coming from numerous geological and mining institutions, including the universities, it seemed that geology had proved itself to be one of the most important sciences in the minds of perhaps the most practical nation in the world. The International Geological Congress held in 1933 in Washington thus appeared to be most important of the sessions so far held. It did not matter very much where the next meeting would be held provided it was in a convenient place, and so a qualified invitation from London was considered until the offer from Moscow was renewed. It was then decided that the Soviet invitation was both of long-standing and cordial and so Moscow was fixed upon.

The Seventeenth Session held in Moscow, 1937.

So much has happened in Russia during the last twenty years—since the Great October Revolution of 1917 when the Bolshevik regime definitely assumed control of the country—that a visit to the Union of Soviet Socialist Republics, under almost any circumstances, must be interesting. So much has been reported about the conditions in that country and so many claims have been made by Soviet geologists and other scientists in regard to their discoveries in the field and in the laboratory that foreign scientists were sceptical of these claims. In these circumstances my selection by the Director, Geological Survey of India, to go to Moscow as the representative of the Government of India to attend the Seventeenth International Geological Congress was most enviable, especially as I was the only delegate from India. In the previous Seventh International Geological Congress held in Russia, in St. Petersburg in August 1897, it happened that there was no delegate from India owing to some delay in the selection of a representative—Mr. C. L. Griesbach—who was unable to attend when recommended.

Before the Congress meeting on July 21st excursions had been arranged for visits to the north (Kola peninsula and Karelia), to the south (Ukraine and Crimea), to the Caucasus and to the Volga-Urals area (Permian excursion). After the Congress closed, excursions were arranged to visit the Petroleum occurrences, Siberia, Nova Zembla, and the Urals, in addition to places near Moscow. I attended the Permian excursion as it was closely related to the work I had been doing in India and was probably more palæontological than economic. In fact it was very soon evident that economic geology was the chief concern of the Soviet Government and the subject of mineral resources was the main theme of the papers and discussions at the meetings of the delegates in Moscow, in Leningrad and at the various places visited

during the excursion. It was a subject for complaint during the Russian meetings of 1897 that banquets played perhaps a more important part in the excursions than visits to exposures. We had nothing to complain against the excursions except that some were long days, nor can we say that banquets were too few for we were treated generously everywhere—from picnics in a Bashkirian forest to a banquet in the Kremlin itself. We found the U.S.S.R. to be a geologists' paradise. Nothing seemed to be done in mineral prospecting, the development of mines, the exploration of oil-fields, the erection of metallurgical works, the construction of canals and other engineering structures, and even in the reclamation of lands, without the opinion of the geologists engaged in that district or in direct consultation with the geological authorities in Leningrad.

Each mineral industry—gold, coal, petroleum, salt, mica, phosphates, etc.,—has its own so-called Trust which may have branches all over the U.S.S.R. There is exploration everywhere and mineral and metallurgical works are in course of erection in various parts of the vast territories of the U.S.S.R., which are equal to half the area of Asia and fully four times that of India—yet with a population only half that of India. We were almost bewildered by the immense activity we saw wherever we went throughout the length and breadth of Russia, and it is not too much to say that the enthusiasm of those engaged and their intense pride in all their work showed that a nation had been established and is going forward. Our unbelief in the vast claims slowly disappeared as we travelled and met geologists almost everywhere and saw their maps, their mines, their technical schools and colleges. Somehow it was no shock to us when we learned that over 10,000 geologists were engaged on State surveys or in the Trusts or in Universities and other scholastic institutions. Their equipment is not equalled in India, their museum collections (especially those in Leningrad) are splendid and well housed, their research laboratories are lavishly supplied and their work is equal to any geological work. In physics and chemistry, in geo-chemistry and geo-physical work they have little to learn from other countries. In fact it is difficult to express in words the high standard of the work—whether it be connected with the atomic structure of elements, the study of crystal structure, the synthetic production of minerals, the investigation of mineral associations in ore deposits or pegmatites, or palæontological and palæobotanical determinations—that is being steadily and carefully done in numerous centres.

It may be said that the scientific standard of work is set by the Institutes controlled by the Academy of Sciences, while the efficiency of geological work—mapping, mineral study, etc.,—is guided by the Geological Survey Committee and the Central Geological and Prospecting Institute for Scientific Research (TsNIGRI) in Leningrad. It must not be concluded that a geologist is free to do research work at his own time all the days of his life. This is not the view of the Academy and Survey authorities who are responsible to the Soviet Government from whom the generous grants are obtained for scientific research, expeditions, surveys, prospecting and for exploration and development. The mineral resources of the U.S.S.R. have not only to be found, studied and estimated, but must supply the needs of the country's industries. With all land and minerals belonging to the people, under the control of the Government, nationalization of industries is a fundamental matter and so a great deal can be done to co-ordinate development. It is the policy of the Government to make each Autonomous or Union Republic dependent on its own mineral resources for its industrial wants. Consequently geological search is widespread through the U.S.S.R. Geologists vie with each other to make discoveries and, as may be imagined, subject each other's discoveries to severe scrutiny. It is not wise to claim more than you can justify and there is little place for a geologist lacking energy—the expenditure on his training must be justified either by hard work or great ability.

The point of the Seventeenth International Geological Congress was to show us that Russia is second to none in geological work and we must admit that they have proved all their claims and congratulate them for showing the value of the geologist to their Government.

Weather Prediction.

UNDER the auspices of the National Institute of Sciences of India, a Symposium on Weather Prediction was held in the Meteorological Office, Poona, on the 25th and 26th July, 1938. Various aspects of forecasting of weather were discussed at the Symposium, attention being focussed mostly on the problems facing the Indian meteorologist and the proposed or attempted methods of solution. Thus, papers presented at the meeting concerned long-range forecasting for a whole season as developed in India, medium range forecasts for 10-day periods as developed by the German and Russian Schools, short-range, i.e., day-to-day, forecasting in India with special reference to the use of air mass analysis in this task, the use of upper air data in weather forecasting, thermodynamic studies of the atmosphere with special reference to latent instability, rainfall in north-west India associated with winter disturbances, weather forecasting for aviation and the application of kinematical methods to forecasting.

In his opening remarks PROF. M. N. SAHA, the President of the Institute, referred to the fascination which the art of weather prediction held out to man from the earliest times, to the development of the synoptic chart in this country from the time of Blanford and Eliot and to the subsequent contributions made by the Indian meteorologists to the art and science of weather prediction.

DR. C. W. B. NORMAND welcomed the visitors

to the Symposium on behalf of the Meteorological Department and reviewed briefly the complexities of the problems which faced the meteorologist. At one time, it was sufficient for the forecaster to restrict his attention to rainfall alone. Now the conditions had altered largely; the meteorologist had not only to forecast for storms over the sea and land but had to warn the airman who wanted detailed forecasts of upper winds, of height of clouds, of fog, dust-storms, squalls, etc. A variety of requirements had thus to be satisfied and yet his decisions had to be made quickly. There was no time for lengthy calculation such as would be necessary if he desired to, and could, write complex mathematical equations relating to the weather situation at any instant and solve them to obtain the picture at a future instant. The most hopeful method from the practical point of view appeared to be to focus attention on the identification of air masses, homogeneous within themselves, and to the effects which a mutual interaction between the several air masses would produce. India was the country in which most attention had been paid to the subject of seasonal forecasting and yet, the most that we could do to-day was to give a very general indication of total rainfall over large tracts of the country for a period of two to four months. Dr. Normand concluded by giving a brief general survey of the different aspects of the problem which was to be dealt with in detail by the subsequent speakers.

DR. S. R. SAVUR told the story of seasonal forecasting in India. The first forecast of monsoon rain, mainly based on the data of snowfall on the Himalayas and the Sulaiman range during the preceding January to May, was issued by Blanford in 1886. Eliot who succeeded Blanford added other factors like the southeast trades at Mauritius, Zanzibar and Seychelles, data of south Australia and Cape Colony and " Nile Flood ". But in his method which was mainly graphical, there was much chance of individual bias. A great improvement in foreshadowing monsoon rainfall resulted when Sir Gilbert Walker introduced the more impersonal method of correlation coefficients in place of Eliot's graphical method. The first forecast using a regression equation was issued by him in 1909. In 1924, he worked out six formulæ for forecasting rain in the Peninsula, northeast India and northwest India in which use was made of some 28 factors selected out of a large number after applying the statistical test, now named after him. Mr. Field, the pioneer of upper air work in India, was responsible for suggesting a new factor of special interest, as he was the first to make use of upper air data in seasonal forecasting; his factor is the upper winds of Agra in autumn, to foreshadow the winter rains in northwest India. The re-examination of the data in recent years and the application of the Performance Test showed a diminution in the significance of some of the factors. Nevertheless the total correlation coefficient is still found to be 0·63 for total monsoon rainfall of the Peninsula and 0·64 for that of northwest India and 0·72 for the winter rains of northwest India. The seasonal forecasts issued at present are for (i) the winter rainfall during January to March in northwest India, (ii) the monsoon rainfall during June to September in northwest India and the Peninsula and (iii) the monsoon rainfall during August and September in the same two divisions. Efforts were being made to decrease the period of the forecasts and also the area which they covered. Dr. Savur emphasised that methods of correlation were strictly applicable only when all the quantities correlated varied according to the normal law of distribution. To overcome the handicap introduced by non-normality of distribution found in practice, general methods were being developed but the work was still in its initial stages.

Coming to medium range forecasting, MR. S. BASU explained the method developed by Franz Baur of the German Meteorological Service for forecasting for 10-day periods, a method which depended on a suitable combination of statistics and synoptics. He also explained the composite map method of forecasts developed in Russia by Multanovsky and his collaborators in which the time interval for the forecast was dictated by the prevailing weather situation, each type of synoptic system having its own characteristic persistence. Mr. Basu briefly discussed the possible application of these methods to Indian conditions.

DR. S. N. SEN explained the methods adopted in daily forecasting practice for identification of air masses which, broadly speaking, fell into two classes, oceanic and continental, but could be subdivided into several sub-classes. He illustrated by means of charts certain types of stationary fronts which often developed over the Indian area. He also showed how use was made of stream lines and convergence patterns of air currents aloft deduced from pilot balloon data and cloud movements, along with a knowledge of upper air climatology for identification of air masses and day-to-day forecasting.

DR. PRAMANIK spoke on the application of air mass analysis to the problem of forecasting nor'westers in Bengal.

DR. K. R. RAMANATHAN gave a brief review of the development of upper air work in India and explained how the data helped the issue of forecasts relating to conditions on the ground as well as in the upper air. The data provided the basic information regarding the climatology of the upper air and helped intensive studies of the structure of atmospheric disturbances. He gave a few instances of the use of these data in such studies. For instance, he showed how warm fronts somewhat similar to those in European latitudes were found to be associated with storms and depressions in the Bay of Bengal. The two air masses between which the front formed were the dry cold air from northern India and the moist equatorial air from the south Bay. A modified type of front was associated with the storms of the premonsoon season. In monsoon depressions the main front formed between fresh monsoon air and old monsoon air, the former behaving as a cold mass and the latter as a warm mass. Dr.

Ramanathan also showed a picture of the general circulation of the atmosphere over India as obtained from pilot balloon ascents made for the past few years in this country.

The role of latent instability in the atmosphere formed the subject of an interesting communication by DR. N. K. SUR; in the absence of the author the paper was presented by DR. R. ANANTHAKRISHNAN. The term 'latent instability' which was defined by Normand in 1931 referred to a thermodynamic state of the atmosphere in which, under suitable circumstances, the initial expenditure of a small amount of energy led to the release of a much larger amount of energy. Absence of latent instability was ordinarily associated with dry fine weather with occasionally high clouds of the non-convectional type, while its existence was associated with convective clouds or instability phenomena like dust- or thunder-storms. Interesting series of soundings taken during the formation of storms in the Bay of Bengal and their movement showed the progressive building up of latent instability conditions as a disturbance approached the station and its disappearance as it moved away or dissipated.

MR. S. P. VENKITESHWARAN read an interesting paper on rainfall due to winter disturbances and the associated upper air temperatures over Agra.

DR. S. K. PRAMANIK spoke on the use of upper air data in day-to-day forecasting and illustrated his remarks by charts.

MR. P. R. KRISHNA RAO discussed the problems which demanded attention in weather forecasting for aviators which could be divided into three categories: (i) regional, (ii) route, and (iii) local. In regard to local forecasting he explained the use being made at Karachi of tephigrams of aeroplane ascents in forecasting local convectional phenomena and formation, persistence or clearing of clouds. The soundings by aeroplanes had afforded a valuable aid in this task. He also referred to the question of fog forecasting and remarked how the Taylor Diagram had not proved very successful except in ruling out days when fog was unlikely.

The use of kinematical methods in weather forecasting as developed by Dedebant and Pettersen was explained by DR. S. K. BANERJI. Whenever any pressure system, such as a cyclone, an anticyclone, a trough or a front was in continuous motion, one could from a knowledge of the changes in the 2 to 3 hour period preceding, calculate the velocity and acceleration of each point of the system and foretell the position and configuration of the system during the next 6 to 12 hours. The deepening or filling up of pressure over an area bounded by two closed isobars was equal to the planimetric value of the barometric tendency within the same area. Dr. Banerji illustrated an application of these and other kinematical laws to certain Indian storms, particularly to explain the curvature of the tracks of the storms.

Lively discussion took place at the end of each of the papers mentioned above.

DR. NORMAN who wound up the discussion referred to the future of weather forecasting. He felt doubtful whether any statistical methods applied to surafce data alone would result in much further advance in seasonal forecasting. Here as well as in other branches of forecasting we had to look to the upper air for further improvements in our forecasting capacity. There lay our hope. More data of soundings of the atmosphere by aeroplanes, radio-sondes or balloon meteorographs were needed for day-to-day analysis of the conditions in the upper air which alone would help us to understand the mechanism that was behind the making of weather.

The proceedings terminated with a vote of thanks to the President proposed by Dr. Normand after which two cinematographic films illustrating the evolution of clouds were shown to the audience.

"Ascu"—A Wood Preservative.*

IT is but some five years since "Ascu"—a patented timber preservative treatment—first appeared on the market. A considerable amount of work, both in India and abroad, has been done on the merits and limitations of the method. In 1933, at the instance of the Railway Board, a distinguished Committee enquired into the suitability of this (and of the Falkamesam) process for treating Railway timber, principally of sleepers. Their findings were published in a Report in which they indicated several lines in which further work was desirable. This mass of literature is apt to bewilder the layman who is not always able to view scientific data in true perspective. Meanwhile, in India, preservative timber treatment is just beginning to win general recognition as part of the normal technique in modern timber utilisation. Therefore, in the interests of the individual user as well of the healthy development of timber utilisation in the country, it is opportune that this authoritative publication has appeared.

A general introduction in the book is followed by a summary of the results of tests with "Ascu". In the third chapter is to be found simple and unambiguous instructions, with the aid of diagrams, of the three methods of using Ascu—brush treatment, dipping treatment and pressure treatment. The detailed data on the "Ascu" tests are set out in ten tables, the last one dealing with tests conducted out of India. The prices at which "Ascu" could be bought in bulk and in

* "*Ascu*.—A Wood Preservative (*Indian Forest Records*, New Series, Utilisation," Vol. I, No. 6). By the Forest Research Institute, Dehra-Dun. Pp. 143–87. Price As. 14 or 1*sh*. 6*d*. Delhi, 1938, published by the Manager of Publications.

smaller quantities are given in an Appendix. The inferences which all these data warrant are assessed by the Forest Economist, Captain H. Trotter, in a *Foreword* written with the scientific detachment appropriate to such a publication. It is a great merit of this book that it emphasises again and again that the data are all indicative rather than conclusive. One is apt to overlook that it is a hundred years since pressure creosote treatment was patented by John Bethell; equally old is the zinc chloride method. And still, to-day after all these years, the last word on these processes has by no means been said. "Ascu", but five years old, is thus still in its infancy, and as this book shows, a very promising infancy with every indication that it will stand the test of time.

This very useful publication should appeal to everyone interested in timber preservation. Its value to the research worker would have been even greater by the inclusion of two more appendices—one giving the exact terms of the patent specifications of "Ascu" and another, a bibliography of the literature that has appeared on "Ascu" to date.

EMMENNAR.

The Geological Survey of India.

THE General Report of the Geological Survey of India for the year 1937 just published by the Director Dr. A. M. Heron, is an impressive record of the large volume of work done by the officers of the Department during the past year. During the field season, most of the officers were out on geological survey work mapping in great detail areas of special interest in different parts of India. In the North-East Circle, Dr. Fox and his associates were engaged in surveying the Garo Hills and the Khasi and Jaintia hill districts of Assam. In the North-Western Circle, Dr. Coulson spent some time in Waziristan and made valuable observations having an important bearing on the geology of parts of north-western India. Mr. W. D. West completed his mapping of the Shali area and worked out in detail the structural features of this part of the country. As regards the age of the Shali limestone, Mr. West thinks that its correlation with the Krol limestone cannot be regarded as certain. It is probable that the two series are of the same age but this cannot yet be asserted on definite evidence. In the Southern Circle, Mr. H. Crookshank and Dr. P.K. Ghosh devoted a considerable amount of time to mapping in the Bastar State, as a result of which several interesting observations have been made. According to Mr. Crookshank, the banding of the hematite-quartzite in this area has probably nothing to do with the original stratification of the rocks, but is due to the deposition of iron ore along the planes of cleavage or schistosity of the original ferruginous phyllites or slates. Dr. Ghosh has recorded several phenomena indicating assimilation and hybridisation in the granitic rocks of this area.

In addition to this extensive Geological Survey work, the Department has also found time to assist the general public in connection with the large number of economic enquiries from all over India, regarding the occurrence and possible development of various kinds of mineral deposits. On Engineering and allied questions, especially water supply, the opinion of the geologists of the Survey has been frequently sought not only by private individuals but also by local and provincial governments, and on every one of these occasions, the Department has readily given authoritative and expert advice with commendable willingness. In the Elephanta Caves near Bombay, which are a well-known treasure-house of ancient figures and sculptures of great archæological interest, it is noticed in recent years that there has developed a tendency for the rocks of these sculptured figures to decay and crumble gradually due to natural processes of weathering during the long period of nearly 1400 years during which they have been in existence; and the Government of India recently appointed a Committee to go into this question and suggest the measures to be taken to combat this; and on their request, an officer of the Geological Survey of India—Dr. M. S. Krishnan—was deputed to advise the Committee on the geological aspects of the matter. Dr. Krishnan has investigated this problem thoroughly, and in his Report to the Director-General of Archæology, has made valuable suggestions for the prevention of such decay and disintegration.

The Department is also anxious to educate the layman in geological matters and stimulate in him a general interest in the geology of his country; and with this object in view, attempts are being made to reorganise the Museum so as to make it more attractive and instructive,—an important new feature being the preparation and display of descriptive labels in the several common Indian languages like Hindi, Bengali and Urdu, to enable the public to understand and appreciate the several exhibits. In the Palæontological Section, considerable work in this direction is being done by Dr. M. R. Sahni, under whose direction the fossil galleries have been entirely rearranged and illustrated with restoration drawings of some of the more interesting genera. Notable amongst these are the serial wash drawings illustrating various stages in the evolutionary history of such interesting animals as the Elephant, the Horse, etc.

To those who are frequently inclined to doubt the utility of geology and geologists in public service, a perusal of the present Report gives a good idea of what a well-organised Geological Department could do for promoting the progress and prosperity of a country.

GEO.

The Krishnan Effect.

In a series of papers published in the *Proceedings of the Indian Academy of Sciences* (1934–38), Dr. R. S. Krishnan working in Sir C. V. Raman's laboratory at Bangalore has demonstrated the existence of a new effect referred to by Prof. Gans in a paper in the *Physikalische Zeitschrift* (1936), **37**, 19, as the " Krishnan Effect "—relating to the state of polarisation of the light transversely scattered by certain liquid and solid media. If the incident beam of unpolarised light passing horizontally through the medium be regarded as made up of two beams of equal intensity and unrelated in phase, one with vibrations vertical and the other with vibrations horizontal, the light scattered in a direction normal to the incident beam can be supposed to be made up of four components V_v, H_v, V_h and H_h, the first two arising out of the vertical component and the last two arising out of the horizontal component of the incident beam. The first important observation of Dr. Krishnan which is general in its application is that $H_v = V_h$, whatever be the nature of the scattering medium. This he has called as the *reciprocity relation*. The second fact experimentally observed by Dr. Krishnan is that the depolarisation factor $\rho_h = V_h/H_h$ is less than unity in a large variety of material media, such as critical solution mixtures of liquids very near the critical solution temperature, colloids and optical glasses. In pure liquids it is known that $P_h = 1$ and the above observation signifies that in cases where p_h is less than one, the scattering units are no longer small compared with the wave-length of the incident light. Soon after the publication of his results on molecular clustering in binary liquid mixtures, Prof. Gans put forward a theoretical explanation of the observed anomalous depolarisation (i.e., $p_h < 1$). He finds that the Krishnan effect requires the existence of optically anisotropic clusters which are strongly non-spherical in shape. In a later paper (*Phys. Zeit.*, 1937, **38**, 625) however he has questioned the validity of the reciprocity theorem.

Recently in the *Proceedings of the Royal Society*, 1938, **166**, 425, Dr. Hans Mueller has theoretically discussed Dr. Krishnan's investigations and has completely confirmed the validity of his conclusions from very general theoretical considerations. He has derived the reciprocity relation and has shown that the objections raised by Prof. Gans are not valid. Based on Dr. Krishnan's work he has also put forward the theory for the structure of optical glasses. The theoretical considerations of Dr. Mueller upholds the view put forward by Sir C. V. Raman in *Nature*, 1922, **199**, 138, that the intense scattering of light in optical glasses is molecular in origin and is an inherent property of the amorphous state of matter. It is remarkable to find that the magnitudes of the Krishnan effect observed in optical glasses follows very closely the order predicted by Dr. Mueller in his paper.

The new method of experimental observations of the scattered light developed by Dr. Krishnan and the principal results emerging therefrom described above have opened out a wide vista of applications in the study of colloidal systems and the amorphous state of matter. Dr. W. Lotmar has made a general survey of these investigations in the current number of the *Helvetica Chemica Acta*, 1938, **21**, 792.

SCIENCE NOTES.

George Ellery Hale (1868–1938).—Dr. George Ellery Hale, who died on February 21, was by common consent the " greatest builder of modern astronomy ". When he was only 22 years old, he established with his father's financial aid, the Kenwood Astrophysical Observatory, where he invented the spectroheliograph. In 1892, with the munificence of Charles T. Yerkes, he was enabled to found the Yerkes Observatory with its 40-inch telescope which is still the world's largest refractor.

In 1904 the Mount Wilson Observatory was established through the efforts of Dr. Hale. The Observatory, perched on the mile-high peak, was essentially meant for solar observations. In 1914, Dr. Hale obtained from John D. Hooker, a sum of $ 45,000 for a 100-inch telescope disc and with the help of the Carnegie Foundation, the giant telescope was completed and mounted in the Observatory. Dr. Hale retired in 1923 owing to failing health but pursued his researches in his private observatory at Pasadena. Here he invented the spectrohelioscope. In April 1928, he published in *Harpers's Magazine*, an article, wherein he indicated the need for, and the practicability of, a 200- or even a 300-inch telescope for astronomical research. The 200-inch telescope is now in the process of being built and it is hoped that by 1940 the instrument will be completed and mounted in the new Observatory on Mt. Palomar, as a monument to the memory of George Ellery Hale.

* * *

The American Museum of Natural History, The Sixty-Ninth Report of the Museum for the year 1937, gives a succinct account of the activities of what, by reason of its collection and scientific staff, may be considered the largest organization of its kind in the world. This great educational institution has an ' Exhibition area of 23 acres, collections on exhibition and available for study valued at over $ 30,000,000 and a force of approximately 451, who are paid in round figures $ 1,000,000 a year in salaries to carry on the work '. The scientific and educational work comprise expeditions, purchase of collections, preparation of exhibits, changing old exhibits and developing new ones, publication and research by the scientific staff. In an introductory note to the Report, President Fredrick Trubee Davison draws attention to the serious financial condition

of the Museum. In the year 1936, a $ 10,000,000 Ten Year Development programme was announced, which was definitely organised in the year 1937. The response by hundreds of friends of the Museum was most gratifying. In order that the American Museum of Natural History may foster its functions, ' it must not stand still. It certainly must not retrogress. It must go forward '.

In spite of the declining income and resulting curtailment in many of its most important activities in scientific research, the amount of original work turned out by the staff of the Museum is impressive both in regard to quality and volume.

It would hardly be possible to do any justice to the numerous activities of the Museum in a brief note. Among the recent exhibits, mention must be made of the Haydon Planetorium, now in its third year of operation, which 'holds a unique place among educational institutions of our great city, for here the science of Astronomy is made a fascinating study to even the youngest visitors. And apart from its educational value, it continues to present a form of entertainment that gives the visitor a never-to-be-forgotten experience of insipration and beauty '. In the section devoted to exhibits in ' minerology ' a number of interesting additions were made. Mention may be made of a large rock crystal sphere mounted on a tall pedestal, beneath which is placed a device consisting of rotating discs of coloured glass, throwing a cycle of colour combination through the quartz sphere which acts as a ' cosmic colour mixer '. The effect of the introduction of the ' crystalight ' has been to double the attendance in the Morgan Hall, in which this exhibit has been housed. New exhibits were also added to the section in Vertebrate Palæontology, Geology, Living Invertebrates, Entomology, Ichthyology, Herpetology, Ornithology, Mammalogy, Anthropology, Comparative and Human Anatomy and Experimental Biology. In the last-named section the Theodore Roosevelt Memorial Hall has been transformed into one of the most interesting exhibits in the Musuem. " Hardly a day goes by without some visitor to the Museum wanting to know why certain animals behave in particular ways. The mechanisms regulating the behaviour of animals and men are fairly well known ; but no museum has until now attempted to show that various mechanisms in the form of a well-rounded exhibit. The chief reason for this is that behaviour is dynamic, requiring exhibits with parts which move when the visitor presses a button.' Exhibits of this type can fascinate the public while telling a serious scientific story. There are other dynamic exhibits telling the story of the animal mind. With the help of a group of artists, sculptors, and technicians, a series of exhibits have been built up showing the ' world as seen through the eyes of a dog, hen, trout, snapping turtle and house-fly '.

The contrast is obvious between such wide museum activities and what is possible in the understaffed and inadequately financed musuems to which we have grown accustomed in India. The need for a permanent Expert Committee to deal with the situation is urgent.

* * *

Mysore Geological Department.—In the first few pages of the latest *Records of the Mysore Geological Department* (Vol. XXXVI, 1937) recently published, Mr. B. Rama Rao, Director, gives a general report of the work of the Department during the year 1936–37, under several headings such as Administrative, Mining and marketing of minerals, Geological survey, Mineral-surveying and prospecting, Engineering and water-supply questions, etc., and in all these sections the work done by the officers of the Department is of a kind which will be highly appreciated both by the Government and the general public. In addition to the investigation of special problems connected with the useful aspects of geology on the economic and engineering side, about which a number of short reports have been published, the *Record* includes a notable contribution on the purely scientific side—a paper on—"The Cordierite Hypersthene granulites and their associated schistose rocks from Bidaloti, Mysore State " by Messrs. B. Rama Rao and T. P. Krishna Char. In the Bidaloti area, which is less than a square mile in extent, occurs a complex and highly metamorphosed suite of rocks comprising such interesting members as hornblende granulites, pyroxene granulites, cordierite hypersthene granulites, sillimanite quartzites, etc. The complicated geology of this area has been thoroughly worked out and the rocks examined in detail. Of these, the most interesting are the cordierite hypersthene granulites ; and from a complete study of their mineralogical, chemical and field characters, the authors have come to the conclusion that these rocks were originally true sediments, their present condition being due to repeated cycles of metamorphism by different igneous intrusions, which have also materially affected their chemical composition. It will be remembered that it was from these cordierite hypersthene granulites that a new orthopyroxene was recently described by Mr. B. Rama Rao in collaboration with Prof. L. Rama Rau of the Central College.

The activities of the Department during the year under review were many and varied ; and we have no doubt that under the enthusiastic guidance of its present Director the work of the Department will continue to expand both in its scope and its usefulness. GEO.

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The Third Report of the **Royal Institute of Science,** Bombay, covers a period of three years (1934–37) and constitutes an interesting and valuable document from several points of view. Of significant interest is the volume of original work carried out at the Institute by the members of Staff and their associates, although burdened with teaching and administrative duties. Professor Wheeler and his colleagues in the Department of Chemistry are responsible for about 65 per cent. of the output. Abstracts of the 94 lines of research in progress in the four Departments of Physics, Chemistry, Botany and Zoology are given in the Appendix, and these are helpful to workers in other parts of India in avoiding wasteful duplication. It should be a matter of pride for the Institute that only 3·6 per cent. of its post-graduate students for the period 1925–37

remain unemployed. Writing about "Future Progress", the Report adds: "A satisfactory volume of research output has been attained. *Improvement, however, is to be sought in the quality of the research work.* To do this it is essential to attract good students to stay on after they have gained the M.Sc. degree, and work for the PH.D. This has proved unexpectedly difficult; as will be seen from Appendix F, practically all the M.Sc. graduates obtained posts, and although a number of those with employment try to do part-time work for the PH.D. degree, experience has shown that progress with part-time work only, is slow and erratic. Post-M.Sc. scholarships do not completely solve the difficulty. It has been the experience of both the Institute and the University that students holding such scholarships will surrender them willingly and if necessary refund the money paid to them if they are offered a post. *A good deal of time and money is wasted on such students who leave with little notice in the middle of a piece of planned research. Students appear to enter for Ph.D. work merely to fill in their time until they obtain employment.* As employers come to realise the value of higher degrees and suitably reward the possessor of a PH.D. degree, the position will probably improve." This statement holds good in the case of other institutions as well. We wish other Universities and research institutes in the country issue their reports on this model. It may perhaps be worthwhile for the Inter-University Board to discuss this matter and arrive at some uniformity in issuing periodical reports of the various research centres in the country.

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The **Annual Report of the Imperial Dairy Expert,** for the year ending June 1937, embodies the first year's activities after the separation of the Office of the Dairy Expert from the Imperial Agricultural Research Institute, New Delhi, and made an independent unit under the direct control of the Government of India. During the period under report, there was a remarkable manifestation of public interest in the Dairy Industry as evidenced by the large number of requisitions received for help and advice in starting dairy farms, foundation herds for breeding pedigree stock, etc. The Appeal issued by H. E. the Viceroy of India for the improvement of the cattle-wealth of the country and the holding of the All-India Cattle Conference at Simla (May 1937), have served to focus public attention on this nation-building industry. During the year Dr. Wright visited India, at the invitation of the Imperial Council of Agricultural Research, to conduct a survey of the Dairy Industry in India and make recommendations for its proper development.

During the past few years the Dairy Industry has made great progress. In his introduction to the Report, the Imperial Dairy Expert has compared the state of the industry to-day with what it was two decades ago when "except for the work done in the Military Dairy Farm with the special object of meeting the demands of British Troops, the industry in general, was in a morbid condition". To-day, the condition is different; the public have begun to realise that the industry is of vital importance to the country and attempts are being made to develop the industry on scientific lines. The Imperial Dairy Expert received no less than 25 enquiries for information regarding the manufacture of products like casein, condensed milk, milk powder and ghee on a factory-scale. Enquiries were also received from butter manufacturers for special cultures for improving the quality of butter. There is also an increased demand for training in Dairying. All these are encouraging signs which go to show that the future of the Dairy Industry in India is assured.

The Imperial Dairy Expert has, under his administrative control, the Imperial Dairy Institute, Bangalore, and the affiliated centres at Wellington and Anand. The Institute at Bangalore is the main centre of educational and scientific activities. The Milk Depot at Wellington is run purely as a commercial concern and the Research Creamery at Anand remains closed, pending the decision of the Government on Dr. Wright's Report.

The total number of students trained during the year is 55. In the laboratory, attention was devoted mainly to problems that have immediate application to the industry. Seven research papers were published during the year.

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We have been favoured with a mimeographed copy of **A Method for Preparing Palmyra Jaggery for Refining,** by Victor M. Hinchy of West Kensington, London, W.14. This subject is one of topical interest in view of the programme of prohibition which several of the provincial governments in the country have in view. Those interested in this topic may usefully get into touch with the author.

* * *

Industrial Possibilities in the Tinnevelly District.—The Tinnevelly District Commercial Association has issued a 38 page brochure, dealing with some of the more important commercial possibilities offered by the agricultural, forest, marine and other natural resources of the District (*Some Possible Industrial Ventures in the Tinnevelly District*, by A. V. Varadaraja Iyengar, D.SC., A.I.C.). As is the case with other parts of this country, we have "poverty in the midst of plenty", an unfortunate circumstance which is largely due to the paucity of the Government and the public in utilising competent technical talent in exploiting the resources. The Tinnevelly District Commercial Association which has inspired the publication of this brochure, might also take up the responsibility of giving effect to such of the recommendations which may have the prospect of immediate success. This is a report which deserves the careful consideration of all those interested in the prosperity of the District.

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The Grading of Aggregates and Workability of Concrete.—In placing concrete, whether for roads or structures, a factor of the utmost importance is the control of the workability of the mix. To control the workability solely by variation of the water content may lead to a needless and uneconomic sacrifice of strength.

In a recent report (Road Research Technical Paper No. 5; H. M. Stationery Office, London),

it is shown that by adjusting the grading of the aggregates to fall within certain limits, it is possible for the engineer to obtain the best combination of workability and strength for his purpose.

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Forest Products Research Board for the Year 1937.—The work of the Forest Products Research Laboratory for the year 1937, is summarised in a recent report issued by H. M. Stationery Office. Descriptions of the investigations into the structure, seasoning and preservation of timbers, their working qualities, physical properties and chemical composition are also included in the Report. Among other important subjects discussed are laminated wood products and fibreboard packing cases. Typical examples are also given of the help afforded to industry and to the general public by the Research Board.

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Royal Institute of Science, Bombay.—Mr. D. V. Bal of the Zoology Department, has been awarded the Sir Mangaldas Nathubhoy Scholarship of the Bombay University for the study of Marine Biology in England.

The National Institute of Sciences, India, will hold a Symposium on "Recent Work on the Synthesis of Naturally Occurring Substances" at the Royal Institute of Science, Bombay, on the 26th and 27th September. The Vice-Chancellor will perform the formal opening. Prof. M. N. Saha is expected to attend.

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University of Mysore.—1. *Personnel*: (1) Miss M. C. Albuquerque, L.R.C.P., M.R.C.S., L.M., Lady Medical Officer, Vani Vilas Hospital, Bangalore, was appointed Principal, Medical School, Bangalore, *vice* Rajasevasakta Dr. B. K. Narayana Rao appointed as Senior Surgeon. (2) A Professorship for Applied Mathematics was sanctioned for the Central College and Dr. B. S. Madhava Rao was appointed to it.

2. *Meeting of the Academic Council.*—A meeting of the Academic Council was held on the 27th August 1938. Among the propositions that were passed, mention may be made of the following: (1) Re-instituting French as a second language and making provision for Latin also as a second language for the Intermediate, B.A., and B.Sc. examinations. (2) Providing the following additional group of optional subjects for the I.Sc. examination and the B.Sc. Pass Degree examination: Economics, Geology, Chemistry. (3) Scheme regarding the course of studies in Politics for the B.A. Honours degree examination. (4) Reducing the minimum for compartmental pass in the Intermediate Examination.

3. *Elections.*—(1) Mr. V. L. D'Souza, B.A., B.Com. (Lond.), Professor of Economics, Maharaja's College, Mysore, was elected to the University Council by and from the Academic Council *vice* Rajasevasakta Dr. B. K. Narayana Rao appointed as Senior Surgeon. (2) Sastravaidyapravina Dr. S. Subba Rao, B.A., M.B.C.M., etc., Retired Senior Surgeon, was elected as a member of the Mysore Medical Council *vice* Rajasevasakta Dr. B. K. Narayana Rao, by the Faculty of Medicine.

4. The Sri Krishnarajendra Silver Jubilee Lecture, 1938 (founded by Mr. V. Subrahmanya Iyer, B.A., Retired Registrar of the University) was delivered at Bangalore on the 27th August 1938, by Rao Bahadur Dr. A. Lakshmanaswami Mudaliar, M.D., F.C.O.G.

5. Government Orders were passed ordering the transfer of the degree class in the Maharani's College, Mysore, to Bangalore, with effect from 1939–40.

6. *Convocation.*—The 21st Annual Convocation of the University will be held at Mysore on Thursday, the 6th October 1938. Rev. C. F. Andrews has been invited to deliver the Convocation Address.

7. *Recognition of Examination.*—The B.T. Degree examination of this University is recognised by the University of Bombay as equivalent to its B.T. degree examination for purposes of admission into M.Ed. examination.

* * *

Lucknow University.—The following candidates are declared eligible to receive the Degree of D.Sc.:—(1) Mr. Shyam Sundar Lal Pradhan, M.Sc. The topic of his Thesis was "Morphological Studies on some Indian Coccinellids". (2) Mr. Daya Shankar Surbahi, M.Sc. The topic of his Thesis was "The Anatomy of Indian Carp, *Labeo rohita*".

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Mr. K. N. Kaul, Research Assistant to Prof. B. Sahni, appointed Demonstrator of Botany at the University of Lucknow. Mr. R. V. Sitholey, research student, selected as Research Assistant in place of Mr. K. N. Kaul. Mr. Bahadur Singh, research student in the same department, appointed Lecturer in Botany at the Balvant Rajput College, Agra. Mr. T. N. Srivastava, research student in Botany at Lucknow, appointed an Indian Forest Service probationer at Dehra Dun. Mr. N. P. Choudhury, another research student in the Department, appointed Demonstrator in Botany at the Agricultural College, Mandalay. Dr. S. C. Varma, Ph.D. (London), Demonstrator in Botany at Lucknow University, appointed Lecturer in Botany at the Agricultural College, Mandalay.

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We have pleasure in announcing that **Hon'ble Sir S. M. Sulaiman, Kt., M.A., LL.D., D.Sc., F.N.I., Delhi; Mr. E. F. G. Gilmore, B.Sc. (Hons.), M.I.M.E.,** Director, Industrial Research Bureau, Calcutta; **Dr. S. Siddiqui, D.Phil. Nat.,** Director, Research Institute, A. & U. Tibbi College, Delhi; and **Khan Bahadur Dr. M. Afzal Husain, M.A., M.Sc., I.A.S.,** have accepted our invitation to join the Board of Editorial Co-operation.

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Announcements.

Federation of University Women in India.—The following Fellowships are available to members of the above Federation 1939–40:—

1. International Senior Fellowship in Arts (£ 250).
2. International (A.A.U.W. Fellowship Crusade) Fellowship ($ 1500).
3. International Residential Fellowship at Crosby Hall (£ 100).

4. Helsinki Hospitality Fellowship.
5. Bursaries at Crosby Hall.
6. Research Fellowship, University of Sydney, Australia (1939–41) £200 per annum.

Further information regarding the above can be had from the Hon. Gen. Secretary, Federation of University Women in India, 31, Adder Road, Cumballa Hill, Bombay.

International Technical Commission of Pharmacopœial Experts.—At the recent session of the Health Organization of the League of Nations, a Commission was appointed to carry on the work of the Brussels Conference for the establishment of standards for potent medicines. The Committee consists of C. H. Hampshire, Chairman (London), H. Baggesgarad (Copenhagen,) V. E. Zunz (Brussels), M. Tiffeneau (Paris), R. Eder (Zurich), L. Van Itallie (Leyden), E. Fullerton Cook (Philadelphia), and a member of the Union of Soviet Socialist Republics.

The Brussels Conference was the outgrowth of earlier efforts to establish an International Pharmacopœia. In 1902 a group of pharmacists from Brussels, in the name of the Belgian Government, issued invitations to practically all nations of the world to participate in a Conference for the purpose of establishing uniformity in the definition and strength of the more potent medicines in use throughout the world.

A second Conference was called for 1914, but was postponed because of the World War. The second Conference was finally assembled at Brussels in 1925, with representatives from more than 40 nations participating. Additional uniformity in standards and preparations was recommended and the Conference adjourned after passing recommendations that its work be taken over by the Health Organization of the League of Nations.

The establishment of a Pharmacopœial Secretaryship at the League, has been the basis for discussion for many years but the actual establishment of the programme has only now been completed. The Chairman of the Committee is the Secretary of the British Pharmacopœial Commission, which has recently published the First Supplement to the *British Pharmacopœia*.

The International Commission plans to compile a list of the more important medicines used throughout the world and invite the National Pharmacopœial Commissions in various countries to prepare model monographs, which, when finally approved, will be presented to the Pharmacopœial Commissions of the world with the hope that they may assist in bringing about greater uniformity in titles, definitions, descriptions, tests for identity and purity, and methods of assay.

It is hoped also that it will compile the pharmacopœial literature of the world for the use of all pharmacopœial commissions (*Ind. and Eng. Chem.*, News Edition, 1938, **16**, 376).

The attention of our readers is drawn to a review on **"Reports on Progress in Physics"** appearing elsewhere in this number. The volume is a comprehensive review, by leading physicists, of recent work in general and atomic physics, and can be purchased from the Manager, Physical Society, 1, Lowther Gardens, Exhibition Road, London S.W. 7 (Price 20*sh.* post free).

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We acknowledge with thanks, receipt of the following :—

"Agricultural College Magazine, Nagpur," Vol. 13, No. 4.
"Agricultural Gazette of New South Wales," Vol. 39, No. 8.
"Journal of Agricultural Research," Vol. 57, No. 1.
"Monthly Bulletin of Agricultural Science and Practice," Vol. 29, No. 7.
"Agricultural and Live-stock in India," Vol. 8, Part 4.
"The Philippine Agriculturist," Vol. 26, No. 3.
"Journal of the Royal Society of Arts," Vol. 86, Nos. 4470–74.
"Biochemical Journal," Vol. 32, No. 7.
"Journal of the Institute of Brewing," Vol. 43, No. 12 and Vol. 44, No. 1.
"Chemical Age," Vol. 39, Nos. 995–99.
"Journal of Chemical Physics," Vol. 6, No. 8.
"Journal of the Indian Chemical Society," Vol. 15, No. 6.
"Berichte der Deutschen Chemischen Gesselschaft," Vol. 71, No. 8.
"Journal de chemie physique," Vol. 35, No. 6.
"Russian Journal of General Chemistry," Vol. 8, Nos. 5 and 6.
"Experiment Station Record," Vol. 79, Nos. 1–2 and Index to Vol. 77.
"Indian Forester," Vol. 64, No. 9.
"Transactions of the Faraday Society," Vol. 34, No. 208.
"Forschungen und Fortschritte," Vol. 14, Nos. 22–24.
"Bulletin of the Health Organization, League of Nations," Vol. 7, No. 3.
"Medico-Surgical Suggestions," Vol. 7, No. 8.
"Calcutta Medical Journal," Vol. 34, No. 3.
"Mathematics Student," Vol. 5, No. 4.
"Review of Applied Mycology," Vol. 37, Nos. 4–7 and Index to Vol. 36.
"Nature," Vol. 142, Nos. 3587–90 and Index to Vol. 141.
"Journal of Nutrition," Vol. 16, Nos. 1–2.
"Proceedings of the Royal Society of Edinburgh," Vol. 57, Parts 1–4 and Vol. 58, Part 1.
"Research and Progress," Vol. 4, No. 5.
"Canadian Journal of Research," Vol. 16, Nos. 6 and 7.
"Sky," Vol. 2, No. 10.
"The Indian Trade Journal," Vol. 130, Nos. 1677–81.

Catalogues.

Wheldon and Wesleys, Ltd., London. (1) "Books on Microscopy," (2) "Natural History and Science".

The Forest Research Institute, Dehra Dun—"Classified Catalogue," 1934.

ACADEMIES AND SOCIETIES.

National Academy of Sciences, India:

April 1938.—M. A. H. SIDDIQI: *The Genito-urinary System of the Indian Ground Squirrel* (Funambulus palmarum).—The gross anatomy of the male genito-urinary system has been described. A microscopic study of the entire lower portion of the system has also been made. J. DAYAL: *On a New Species of the Genus* Astiotrema *Looss.*, 1901, *from the Intestine of a Freshwater Fish*, Clarias batrachus *(from Lucknow).—Astriotrema dassia*, a small trematode, 2·2 mm. long by 0·42 mm. broad is described. A key to the species of the genus is given. M. ABDUSSALAM: *On the Occurrence of Skrjabinema ovis* (Skrjabin, 1918) in India.—*Skrjabinema ovis* has been recorded as occurring in a fat-tailed sheep, born and reared at the Allhabad Grantee Farm, Jahania (Punjab), for the first time in India. U. N. CHATTERJI: *Studies on the Effect of Alcohol on the Respiratory Rate of Leaves.*—The acceleration of respiratory rate produced by alcohol decreases with time.

Indian Academy of Sciences:

August 1938. SECTION A.—B. F. FERREIRA AND T. S. WHEELER: *A Study of the Benzoin Reaction*—VI. *The Effect of Temperature Variation on the Benzoin Reaction.*—In the absence of solvents and diluents, the homogeneous auto-catalytic reaction remains unaltered between 80° and 110° C. while the slow heterogenous reaction has its rate approximately doubled for each 10° C. rise in temperature. T. M. K. NEDUNGADI: *Diffraction of X-rays in Organic Glasses.*—Pictures have been taken with glycerine, salol and benzophenone, both in the liquid and the glassy state and compared. BISHAMBHAR DAYAL SAKSENA: *Raman Spectra of Some Organic Bi-cyclic Compounds. Naphthalene, Decaline, Tetralin, Indene,* Trans-β-*Decoline and* Trans-β-*Decalol.*—Polarisation measurements have also been made except for *trans*-β-Decalol, and the characteristics agree with the group theory results. The *cis-* and *trans-*lines of decaline have been separated. S. BHAGAVANTAM AND T. VENKATARAYUDU: *The Normal Modes and Frequencies of the Sulphur Molecule.*—These have been worked out on the assumption that the eight atoms in the molecule occupy the corners of a puckered octagon, and the conclusions are in agreement with the observations. Detailed expressions are also derived for the normal frequencies by postulating three types of forces, namely, primary valence, directed valence and repulsive forces. S. BHAGAVANTAM AND T. VENKATARAYUDU: *Raman Spectrum and Specific Heat of Sulphur.*—The specific heat of sulphur is represented as the sum of a Debye function and a number of Einstein functions associated with the various normal frequencies. The calculated values compare favourably with the observations. S. BHAGAVANTAM AND T. VENKATARAYUDU: *The Normal Frequencies of Phosphorus* (P_4).—By the application of group theoretical methods, the frequencies and specific heat of phosphorus have been calculated and shown to be in agreement with observations. K. NAGABHUSHANA RAO: *Diffraction of Light by Ultrasonic Waves.*—The results of Raman and Nath's general theory are shown to be in complete agreement with Van Cittert's theory. The amplitude function for oblique incidence is developed *in extenso* in a series of Bessel functions. K. S. K. IYENGAR: *On Linear Transformations of Bounded Sequences* —III.

August 1938. SECTION B.—H. CHAUDHURI AND MOHD. UMAR: *Molds of the Punjab—I. The Aspergilli.* H. CHAUDHURI: *Molds of the Punjab—II. The Penicillia.* G. N. RANGASWAMI AYYANGAR AND M. A. SANKARA AYYAR: *Linkage betweeen a Panicle Factor and the Pearly-chalky Mesocarp Factor (Zz) in Sorghum.*—A factor Pa_1 produces loose conical earheads: factor pa_1 results in compact spindle-shaped earheads. These factors Pa_1 pa_1 affecting the panicle shape are closely linked to the factors Zz governing the thickness of mesocarp and the deposit of starch in it, with a cross-over value of 1·07 per cent.

Indian Chemical Society:

May 1938.—B. N. GHOSH AND S. S. DE: *The Effect of Hydrogen-ion Concentration, Electrolytes and of Normal and Immune Sera on the Cataphoretic Velocity of* Leishamania tropica—*Part I.* S. N. RAY: *Effect of Hyperthyridism on the Metabolism of Vitamin C.* TEJENDRA NATH GHOSH: *Quinoline Derivatives—Part V.* S. C. GANGULI AND DAS-GUPTA: *Studies in Indian Bauxite—Part I. Chromium and Vanadium.* K. M. CHAKRAVARTY: *Catalytic Formation of Methane from Monoxide and Hydrogen—Part V. A Study of the Promoter Effect upon Nickel Catalyst.* K. V. GIRI: *Further Studies on the Hydrolysis of Starch by Sweet Potato Amylase.* SUNIL BIHARI SEN-GUPTA: *Studies in the Fluorescence of Dyestuffs.*

June 1938.—SHIVANANDAN PRASAD, AMRITANSU SEKHAR CHAKRAVARTI AND BALBHADRA PRASAD: *Viscosity and Density of Aqueous Solutions of Mercuric Chloride at* 35°. BASANTA KUMAR GHOSH: *Compounds of Hexamethylenetetramine with Simple and Double Salts of Cobalticyanic Acid and the Nature of Residual Affinity.* PRAFULLA KUMAR BOSE AND SACHINDRA NATH BHATTACHARYA: *Natural Flavones—Part II. On the Colouring Matters of the Bark of* Oroxylum indicum, *Vent.* PRODOSHCHANDRA RAYCHAUDHURY: *Estimation of Chromium by Alkaline Mercuric Oxide.* ATMA RAM AND N. R. DHAR: *Formaldehyde Formation in the Photo-oxidation of Organic Substances and the Formaldehyde Theory of Carbon Assimilation.*

The Dacca Botanical Society:

August 1, 1938.—N. K. CHATTERJI: *Some Aspects of Respiration and Respiratory Quotient of Plants.* S. HEDAYETULLAH AND S. P. RAY CHOUDHURY: *A Note on the Study of* Sclerotium oryzæ. P. N. MAZUMDAR: *Utility of a Planned Garden attached to Schools in Bengal.*